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SERIALS

The following list gives in full the abbreviated citations used after the titles of papers in this issue of GeoScience Abstracts.

Alabama, Geological Survey, Information Series. University.
Alberta Society of Petroleum Geologists, Journal. Calgary.
American Alpine Journal (American Alpine Club). New York.
American Ceramic Society, Bulletin. Easton, Pennsylvania.
American Mineralogist (Mineralogical Society of America). Ann Arbor, Michigan.
Applied Mechanics Reviews (American Society of Mechanical Engineers). New York.
California, University, Publications in Geological Sciences. Berkeley and Los Angeles.
Canada, Geological Survey, Bulletin; Geophysics Paper; Map; Memoir; Paper. Ottawa.
Deep-Sea Research. London-New York.
Economic Geology (Society of Economic Geologists). Lancaster, Pennsylvania.
Geologiya Nefti. Petroleum Geology; an English translation (Review of Russian Geology). Alexandria, Virginia.
Kristallografiya. Soviet Physics: Crystallography; a translation of the journal Crystallography of the Academy of Sciences, U.S.S.R. (American Institute of Physics). New York.
Naval Research Reviews (U.S. Office of Naval Research). Washington, D.C.
North Dakota Geological Survey, Bulletin. Grand Forks.
Oil and Gas Journal. Tulsa, Oklahoma.
RAND Corporation, Report. Santa Monica, California.
Research Council of Alberta, Geological Division, Preliminary Report. Edmonton.
Science News Letter. Washington, D.C.
Seismological Society of America, Bulletin. Berkeley, California.
Southeastern Geology (Dept. of Geology, Duke University). Durham, North Carolina.
Tennessee, Division of Geology, Geologic Map; Information Circular; Report of Investigations. Nashville.
U.S. Geological Survey, Bulletin; Geophysical Investigations Map; Mineral Investigations Map; Miscellaneous Investigations Map; Professional Paper. Washington, D.C.

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GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

184. Souther, J.G. GEOLOGY, TULSEQUAH,
TISH COLUMBIA: Canada, Geol. Survey, Map
960, scale 1:253,440, marginal notes, 1960.

Preliminary series geological map of some 5,000
mi. NW. of Telegraph Creek. Area covers part
he Taker plateau and extends into the Coast Moun-
s. Permian, Triassic, Jurassic, and Tertiary
ks are exposed. Extensive igneous rocks include
idotite of Pennsylvanian or Permian age, Triassic
earlier volcanic rocks, granites of the coast in-
sions, younger Mesozoic basalts and Tertiary
olites and dacites. No mineral deposits of eco-
ic significance occur.--P. Harker.

185. Quinn, Harold A. GEOLOGY, BIG SAND
KE, MANITOBA: Canada, Geol. Survey, Map 45-
9, scale 1:253,440, marginal notes, 1960, 4 refs.

Preliminary series geological map of some 5,000
mi., NE. of Lynn Lake. The whole area is com-
ely underlain by Precambrian metavolcanic, meta-
imentary and gneissic rocks, with some massive,
s contaminated granitic rocks that include granite,
nodiorite and quartz monzonite. Granite pegma-
s and aplites occur in the southern half of the
a as dikes and sills. Some minor mineralized
es contain Cu and Ni but none have been exploited
mercially. Much of the bedrock is obscured by
ial deposits, and large quantities of sand and
vel are found as eskers and kames.--P. Harker.

186. Canada, Geological Survey. HILLSBOR-
GH, ALBERT AND WESTMORLAND COUNTIES,
V BRUNSWICK: Its: Geophysics Paper 803, aero-
netic map, scale 1:63,360, contour intervals 10,
100, and 500 gammas, lat. 45°45'-46°N., long.
30'-65°W., 1960.

187. Canada, Geological Survey. KOUCHIBOU-
AC, NORTHUMBERLAND AND KENT COUNTIES,
V BRUNSWICK: Its: Geophysics Paper 804, aero-
netic map, scale 1:63,360, contour intervals 10,
100, and 500 gammas, lat. 46°45'-47°N., long.
-65°30'W., 1960.

188. Canada, Geological Survey. CHATHAM,
THUMBERLAND COUNTY, NEW BRUNSWICK:
Geophysics Paper 805, aeromagnetic map, scale
,360, contour intervals 10, 20, 100, and 500 gam-
, lat. 47°-47°15'N., long. 65°-65°30'W., 1960.

189. Canada, Geological Survey. TABUSINTAC
ER, GLOUCESTER AND NORTHUMBERLAND
NTIES, NEW BRUNSWICK: Its: Geophysics
er 806, aeromagnetic map, scale 1:63,360, con-
intervals 10, 20, 100, and 500 gammas, lat.
5'-47°30'N., long. 65°-65°30'W., 1960.

190. Canada, Geological Survey. BURNSVILLE,
UCESTER COUNTY, NEW BRUNSWICK: Its:
physics Paper 807, aeromagnetic map, scale
,360, contour intervals 10, 20, 100, and 500 gam-
, lat. 47°30'-47°45'N., long. 65°-65°30'W., 1960.

191. Canada, Geological Survey. GRANDE-
E, GLOUCESTER COUNTY, NEW BRUNSWICK:
Geophysics Paper 808, aeromagnetic map, scale
1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 47°45'-48°N., long. 65°-65°30'W., 1960.

2-2192. Canada, Geological Survey. MONCTON, WESTMORLAND AND ALBERT COUNTIES, NEW BRUNSWICK: Its: Geophysics Paper 809, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°-46°15'N., long. 64°30'-65°W., 1960.

2-2193. Canada, Geological Survey. BUCTOUCHE, KENT AND WESTMORLAND COUNTIES, NEW BRUNSWICK: Its: Geophysics Paper 810, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°15'-46°30'N., long. 64°30'-65°W., 1960.

2-2194. Canada, Geological Survey. RICHIBUCTO, KENT COUNTY, NEW BRUNSWICK: Its: Geophysics Paper 811, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°30'-46°45'N., long. 64°30'-65°W., 1960.

2-2195. Canada, Geological Survey. POINT SAPIN, KENT AND NORTHUMBERLAND COUNTIES, NEW BRUNSWICK: Its: Geophysics Paper 812, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°45'-47°N., long. 64°30'-65°W., 1960.

2-2196. Canada, Geological Survey. POINT ESCUMINAC, NORTHUMBERLAND AND KENT COUNTIES, NEW BRUNSWICK: Its: Geophysics Paper 813, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 47°-47°15'N., long. 64°30'-65°W., 1960.

2-2197. Canada, Geological Survey. WISHART POINT, NORTHUMBERLAND AND GLOUCESTER COUNTIES, NEW BRUNSWICK: Its: Geophysics Paper 814, aeromagnetic map, scale 1:63,360, contour invervals 10, 20, 100, and 500 gammas, lat. 47°15'-47°30'N., long. 64°30'-65°W., 1960.

2-2198. Blackadar, Robert G. GEOLOGY, HOBART ISLAND, BAFFIN ISLAND, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 55-1959, scale 1:253,440, 1960.

Preliminary series geological map of part of the SW. coast of Baffin Island, due W. of Frobisher Bay. Bedrock is entirely Precambrian, and 6 map-units are recognized: granitoid gneiss, quartz-feldspar-hornblende gneiss, crystalline limestone, garnet-biotite gneiss, graphite-biotite schist, gabbro. Predominant structural trend is NW., and metamorphism has obscured much of the stratigraphic control. Magnetite occurs in some of the gneisses, and some prospecting and exploratory work has been carried out. --P. Harker.

2-2199. Gadd, Nelson R. SURFICIAL GEOLOGY, ASTON, QUEBEC: Canada, Geol. Survey, Map 50-1959, scale 1:63,360, marginal notes, 1960.

2-2200. Gadd, Nelson R., and Paul F. Karrow. SURFICIAL GEOLOGY, TROIS RIVIERES, QUEBEC: Canada, Geol. Survey, Map 54-1959, scale 1:63,360, marginal notes, 1960, 2 refs.

2-2201. Gadd, Nelson R. SURFICIAL GEOLOGY, YAMASKA, QUEBEC: Canada, Geol. Survey, Map 43-1959, scale 1:63,360, marginal notes, 1959.

2-2202. Cobb, Edward H. ANTIMONY, BISMUTH, AND MERCURY OCCURRENCES IN ALASKA: U.S. Geol. Survey, Mineral Inv. Map MR-11, 1:2,500,000, 1960.

This map shows the distribution of occurrences of Sb, Bi, and Hg minerals in Alaska. Those occurrences which are known to have yielded a saleable concentrate or refined metal are shown in red; all others are indicated in black. The map also gives a list of references to U.S. Geological Survey, U.S. Bureau of Mines, and Alaska Division of Mines and Minerals reports.--U.S. Geol. Survey.

2-2203. Cobb, Edward H. CHROMITE, COBALT, NICKEL, AND PLATINUM OCCURRENCES IN ALASKA: U.S. Geol. Survey, Mineral Inv. Map MR-8, scale 1:2,500,000, 1960.

This map shows the distribution of occurrences of Cr, Co, Ni, and Pt minerals in Alaska. Those occurrences which are known to have yielded a saleable concentrate or refined metal are shown in red; all others are indicated in black. The map contains a list of references to U.S. Geological Survey, U.S. Bureau of Mines, and Alaska Division of Mines and Minerals reports.--U.S. Geol. Survey.

2-2204. Cobb, Edward H. COPPER, LEAD, AND ZINC OCCURRENCES IN ALASKA: U.S. Geol. Survey, Mineral Inv. Map MR-9, scale 1:2,500,000, 1960.

This map shows the distribution of occurrences of Cu, Pb, and Zn minerals in Alaska. Those occurrences which are known to have yielded a saleable product are shown in red; all others are indicated in black. The map contains a list of references to U.S. Geological Survey, U.S. Bureau of Mines, and Alaska Division of Mines and Minerals reports.--U.S. Geol. Survey.

2-2205. Cobb, Edward H. MOLYBDENUM, TIN, AND TUNGSTEN OCCURRENCES IN ALASKA: U.S. Geol. Survey, Mineral Inv. Map MR-10, scale 1:2,500,000, 1960.

This map shows the distribution of occurrences of Mo, Sn, and W minerals in Alaska. Those occurrences which are known to have yielded a saleable concentrate are shown in red; all others are indicated in black. The map contains a list of references to U.S. Geological Survey, U.S. Bureau of Mines, and Alaska Division of Mines and Minerals reports. --U.S. Geol. Survey.

2-2206. Cooper, John R. RECONNAISSANCE MAP OF THE WILLCOX, FISHER HILLS, COCHISE, AND DOS CABEZAS QUADRANGLES, COCHISE AND GRAHAM COUNTIES, ARIZONA: U.S. Geol. Survey, Mineral Inv. Map MF-231, scale 1:62,500, lat. 32°-32°30'N., long. 109°30'-110°W., 1960.

2-2207. Bromery, Randolph W., K.O. Emery, and James R. Balsley, Jr. RECONNAISSANCE AIRBORNE MAGNETOMETER SURVEY OFF SOUTHERN CALIFORNIA: U.S. Geol. Survey, Geophys. Inv. Map GP-211, scale approx. 1 in. to 15 mi., contour intervals 50 and 250 gammas, lat. 31°30'-34°30'N., long. 117°-121°W., 1960.

Magnetic data obtained from 11 widely spaced aeromagnetic traverses off southern California are shown as profiles and as a regional magnetic contour map. Two linear high-amplitude positive magnetic features which trend northwestward may be correlated with structural basin areas and suggest the existence of "rift zones" intruded by mafic igneous rocks.--U.S. Geol. Survey.

2-2208. Kover, A.N. PHOTOGEOLOGIC MAP OF THE CHACO CANYON-2 QUADRANGLE, McKINLEY COUNTY, NEW MEXICO: U.S. Geol. Survey, Misc. Inv. Map I-315, scale 1:62,500, lat. 35°45'-36°N., long. 107°45'-108°W., 1960.

2-2209. Tennessee, Division of Geology. JACKSBORO QUADRANGLE (CAMPBELL COUNTY), TENNESSEE: Its: Geol. Map GM 136-SW, contour interval 20 ft., scale 1:31,680, lat. 36°15'-36°22'30"N., long. 84°07'30"-84°15'W., 2 secs., 1960.

This quadrangle covers a 60 sq. mi. area (36°15'-36°22'30"N., 84°07'30"-84°15'W.) in Campbell County in eastern Tennessee. It includes portions of the Valley and Ridge province and the Cumberland plateau.

On the plateau are Pennsylvanian sandstone, shale, and coal seams that are nearly horizontal in the westernmost part of the quadrangle. Eastward, they are profoundly affected by the Jacksboro tear fault and by thrusting and folding in the adjacent Valley and Ridge.

Valley and Ridge strata are Cambrian shale and dolomite and Ordovician dolomite, limestone, and shale. These rocks have moderate dip in the eastern part of the quadrangle and steep dip along the folds and faults adjacent to the Cumberland plateau.--R.J. Floyd.

2-2210. Tennessee, Division of Geology. LAKE CITY QUADRANGLE (ANDERSON COUNTY), TENNESSEE: Its: Geol. Map GM 137-NW, contour interval 20 ft., scale 1:31,680, lat. 36°07'30"-36°15'N., long. 84°07'30"-84°15'W., 2 secs., 1960.

The quadrangle is a 60 sq. mi. area (36°07'30"-36°15'N., 84°07'30"-84°15'W.) that lies partly in the Cumberland plateau and partly in the Valley and Ridge province, in eastern Tennessee. The area is mostly in Anderson County but includes a portion of Campbell County.

Strata on the plateau are Pennsylvanian sandstones, shales, siltstones, conglomerates, and coal seams. These beds are gently dipping except along the eastern escarpment, where they are upturned abruptly by thrust faulting. Also thrust to the surface along part of the eastern escarpment in this quadrangle are Mississippian shales, limestones, and cherty limestones; Devonian black shale; and Silurian shale and siltstones with hematite zones.

In the Valley and Ridge province, immediately E. of the escarpment, formations dip generally to the E. or SE. at variable angles. Strata in this area are Ordovician limestone and siliceous dolomite; and Cambrian dolomite, shale, limestone, and sandstone.--R.J. Floyd.

2-2211. Tennessee, Division of Geology. ROCKWOOD QUADRANGLE (ROANE COUNTY), TENNESSEE: Its: Geol. Map GM 123-SW, contour interval 20 ft., scale 1:31,680, lat. 35°45'-35°52'30"N., long. 84°37'30"-84°45'W., sec., 1960.

The quadrangle is a 60 sq. mi. area (35°45'-°52'30"N., 84°37'30"-84°45'W.) in eastern Ten-ssee, along the western margin of the Valley and lge province. A small portion of the Cumberland teau is included in the northwestern part of the adrangle. The area is mostly in Roane County but ludes portions of Cumberland and Rhea counties.

Strata in the Valley and Ridge are Ordovician and nbrian limestones, dolomite, shale, siltstone, l sandstone, which dip generally southeastward at atively high angles. Several thrust faults trend theastward across the quadrangle, and window l klippe structures were mapped in the northwest-n part of the quadrangle.

Pennsylvanian formations of the plateau are sand-ne, conglomerate, shale, and coal seams. These ata are nearly horizontal or gently dipping except he eastern extremity of the plateau, where they strongly affected by Valley and Ridge structure. is map presents a new interpretation of the struc-e along the eastern escarpment in a relatively row belt separating rocks of the plateau from se of the Valley and Ridge. Involved are Missis-pian shale and limestone; Devonian (black) shale; l Silurian shale and siltstone with thin beds of natite and sandstone.--R.J. Floyd.

PART 2. AREAL AND REGIONAL GEOLOGY

also: Mineral Deposits 2-2404, 2-2413; Fuels 440.

212. Armstrong, John E. SURFICIAL GEOL-Y OF SUMAS MAP-AREA, BRITISH COLUMBIA: nada, Geol. Survey, Paper 59-9, 27 p., Map 44-9 (in pocket), scale 1:63,360, table (in pocket), 0, 9 refs.

Area includes 2 main physiographic divisions, the st Mountain area and the Coastal trough. Pleisto-e and recent sediments, comprising the surficial osits include sand, gravel, varved clay, stony y, till, and peat. Glaciomarine deposits contain-isolated sea shells are well represented. The liest surficial deposits (pre-Vashon) are not ex-ed at surface; deep wells show that at least one jor glaciation occurred prior to Vashon time. A tinental ice sheet (Vashon) covered the whole area, retreat is indicated by gravel, stream, and out-h deposits. In post Vashon time Sumas valley ice anced, outwash deposits formed as it waned, and of the area a glacial lake formed in Matsqui valley. most recent deposits (Salish) are still in process ormation as flood plain deposits of the Fraser er. Application of the surficial geology to engi-ring, foundations, sewage disposal, flood control, agriculture is discussed.--P. Harker.

213. McGlynn, J.C. ELBOW-HEMING LAKES EA, MANITOBA: Canada, Geol. Survey, Memoir , 72 p., 2 col. geol. maps (Map 1071A, 1072A, ocket), scale 1:63,360, 11 tables, 1959, 40 refs.

The Elbow-Heming Lakes area [54°45-55°N. 100° -101°15'W.] lies in the Flin Flon-Sherridon-Snow e mineral belt of W.-central Manitoba, where ing developments and prospecting activities are sely dependent on the interpretation of the genesis, uence, and structural relations of the associated cambrian volcanic, sedimentary, and intrusive k types.

According to the present report, the predominantly canic rocks of the Archean Amisk group are partly arated from the adjacent largely sedimentary ata of the Kisseynew gneisses in the northern part of the area by complex fault zones and are partly conformable. The grade of metamorphism varies locally but in general increases from S. to N. Six separate groups of granitic rocks have been distinguished. Petrographic and structural studies have indicated that some of these are intrusive and some are the result of granitization. All the rocks have been cut by faults, and these have exerted the principal control in the localization of many of the mineral deposits of the region.--Auth.

2-2214. Gadd, Nelson R. SURFICIAL GEOLOGY OF THE BÉCANCOUR MAP-AREA, QUEBEC: Canada, Geol. Survey, Paper 59-8, 34 p., geol. map in pocket, scale 1:63,360, table, 1960, 36 refs.

The sequence of glacial and postglacial events described applies to the area in the central part of the St. Lawrence lowland covered by the Grondines, Bécancour, Aston, Trois Rivières, Yamaska, and Upton sheets. The problems of stratigraphic correlation are discussed, and a tentative correlation is presented.

The first of 2 glaciations was pre-Wisconsin or very early Wisconsin. It is represented by some small pockets of reddish-gray varves overridden by Bécancour till. This till was laid down by a continental glacier moving southward from the Laurentian shield to beyond the limits of areas under discussion. Destruction of this ice sheet left the St. Lawrence valley open.

During the St. Pierre interval, a drainage system similar to that of the modern St. Lawrence developed in the valley, and St. Pierre sediments comprising fluvial sands and fresh-water bog deposits were laid down in a broad valley and its major tributaries. Pollen analysis by Terasmae and radiocarbon dates ranging up to 60,000 years indicate that although the climate and age do not seem to correlate directly with the classical Sangamon, the sediments of the St. Pierre interval may belong either to late Sangamon or to very early Wisconsin time.

Towards the end of the St. Pierre interval, the climate cooled, pollen became scarce, and a second ice sheet began to advance from the Laurentian highland into the St. Lawrence lowland. Advancing ice blocked the St. Lawrence valley at some point downstream from the areas under discussion, and an elongate glacial lake, lake Deschaillons, occupied the former interglacial valley. Deschaillons varved sediments accumulated in deposits up to nearly 100 ft. thick. These in turn were overridden by sandy gray Gentilly till, the only till representative of Wisconsin glaciation in the region.

During recession of the second ice sheet the front halted for a time within the mapped areas S. of the St. Lawrence river, and the Drummondville moraine was built across the Bécancour, Aston, Yamaska, and Upton areas. A short period of glaciofluvial deposition followed this halt and then, probably due to destruction of an ice dam downstream, the area was flooded by waters of the Champlain sea, and the St. Lawrence valley was soon cleared of ice. A short readvance of ice into the Champlain sea produced the St. Narcisse moraine that has been mapped across the Grondines and Trois Rivières areas N. of the St. Lawrence.

S. of the St. Narcisse moraine, glacial features of the areas mapped are much modified by wave action, or partially or entirely buried by sediments of the Champlain sea. Clays and silty clays in 3 major facies were laid down in the depressions of the initially glacial topography, and shore features such as beaches, offshore bars and spits of fossiliferous sands and gravels were superimposed on topographic highs that were most affected by wave action in the Champlain sea. The Champlain sea sediments of this region have their characteristic brackish-water fossils.

The age of the Champlain sea is discussed and minimum ages for recession of the sea, based on shell and peat C^{14} dates, range from about 8,000 to about 11,000 years.

Much of the sand superposed on the Champlain sea clay and older sediments is shown to be most probably of estuarine and fluvial origin. It was deposited as delta, terrace, and channel deposits as the environment of the St. Lawrence valley evolved from the brackish-water marine embayment stage, through estuarine and high-level fluvial stages, into the present youthful drainage system.--Auth.

2-2215. Gulf Coast Association of Geological Societies. **FIELD TRIP GUIDEBOOK: RECENT SEDIMENTS OF THE NORTH-CENTRAL GULF COASTAL PLAIN, NOVEMBER 14 AND 15, 1959:** 84 p., 25 pls. incl. illus., maps, secs., Houston, Texas, Nov. 1959, 80 refs.

This guidebook was prepared for the joint annual meeting of the Gulf Coast Association of Geological Societies, the Gulf Coast Section of the Society of Economic Paleontologists and Mineralogists, and the fall regional meeting of the American Association of Petroleum Geologists, Nov. 11-15, 1959. The purpose of these field-trip studies of Recent sediments was stated in the 1958 guidebook on the sedimentology of S. Texas (GeoScience Abstracts 2-834). It is hoped that the 1958 trip and the present study can be extended in the future to cover the northern Gulf of Mexico from southwestern Louisiana to the Florida Keys.

"In the Recent sediments of the northern Gulf of Mexico, we have a classical area for study of both transgressive and regressive types of deposits. The transgressive deposits, which were laid down during the postglacial rise in sea level, surface large segments of the continental shelf and extend inland beneath the modern Gulf Coastal Plain. The regressive deposits, on the other hand, make up the features of the plain and provide a record of coastal progradation during the last few thousand years after sea level reached its present stand. The sand bodies of these regressive deposits, which [are] examined in detail on this field trip, hold special interest for the exploration geologist because of their marked similarity to certain lenticular sands of older rocks which commonly serve as oil reservoirs."--From foreword by M. A. Hanna.

FIELD TRIP ROAD LOGS

First Day - Houston to Beaumont via Galveston Island and Bolivar Peninsula, p. 3-30.

Second Day - Beaumont, Texas, to Vicinity of Creole, Louisiana, and Return to Houston via Lake Charles, Louisiana, p. 31-53.

DISCUSSIONS OF FIELD TRIP STOPS

Stop 1. Oldest Fossil Beach Ridge, Back Side of Galveston Island, p. 55.

Stop 2. Galveston Beach Near Eleven Mile Road, p. 55-56.

Stop 3. Galveston-Bolivar Peninsula Ferry, p. 56.

Stop 4. High Island Beach, p. 56.

Stop 5. Relict Beach Ridge, South of Wildcat Ridge, p. 57.

Stop 6. Sabine Lake-Port Arthur Pleasure Pier, p. 57-58.

Stop 7. Cameron Mudflat, p. 59.

Stop 8. Oak Grove Ridge, p. 59.

Stop 9. Little Chenier, p. 60.

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LeBlanc, R.J., and W.D. Hodgson. Origin and Development of the Texas Shoreline, p. 63.

Bernard, H.A., C.F. Major, Jr., and B.S. Parrott. The Galveston Barrier Island and Environs - A Model for Predicting Reservoir Occurrence and Trend, p. 64-66.

Kane, H.E. Late Quaternary Geology of Sabine Lake and Vicinity, Texas and Louisiana, p. 67.

Byrne, J.V., D.O. LeRoy, and C.M. Riley. The Chenier Plain and its Stratigraphy, Southwestern Louisiana, p. 68.

Gould, H.R., and E. McFarlan, Jr. Geologic History of the Chenier Plain, Southwestern Louisiana, p. 69.

Hsu, K. Jinghwa. Size, Sorting, Mineralogy, and Chemical Composition of the Recent Sands of the Northern Gulf Coast, p. 70.

DESCRIPTION OF OIL FIELDS, BOLIVAR PENINSUL

Parker, Herbert. Caplen Field, Bolivar Peninsula, Galveston County, Texas, p. 73-76.

Barnes, C.W. High Island Salt Dome, Galveston County, Texas, p. 77-78.

2-2216. McGlamery, Winnie, and Earl L. Hastings. **GUIDE BOOK TO SELECTED OUTCROPS OF THE EUTAW FORMATION AND SELMA GROUP NEAR MONTGOMERY, ALABAMA:** Alabama, Geol. Survey, Inf. Ser. 18, 14 p., 2 maps, chart, Apr. 1960, 7 refs.

This field trip was sponsored by the Geological Survey of Alabama and the Alabama Academy of Science, Apr. 2, 1960. Outcrops of the Upper Cretaceous Eutaw formation and Selma group on Catoma Creek and Alabama River were visited. The occurrence of the Eutaw and Selma formations as a fault block in the Tuscaloosa group adjacent to Precambrian(?) Ashland mica schist just S. of Wetumpka indicates major post-Cretaceous faulting in this area. The guidebook includes a discussion of stratigraphy and 2 road logs: 1) Catoma Creek Falls (Eutaw formation) and Alabama River (Eutaw-Selma contact); and 2) Jasmine Hill (Eutaw-Selma fault block) and Wetumpka (Ashland schist-Tuscaloosa unconformity).-- A.C. Sangree.

2-2217. Miller, Robert D., and Ernest Dobrovolny. **SURFICIAL GEOLOGY OF ANCHORAGE AND VICINITY, ALASKA:** U.S. Geol. Survey, Bull. 1093, 128 p., 10 pls. (6 in pocket incl. geol. map, scale 1:63,360), 7 figs. incl. illus., chart, graphs, 7 tables, 1959, 76 refs.

Argillite, graywacke, chert, and altered acidic and basic igneous rocks, constitute most of the pre-Cretaceous(?) rocks in the Anchorage area. Metamorphosed limestone crops out along Turnagain Arm.

Surficial deposits are divisible into 3 main age groups - pre-Wisconsin, Wisconsin, and Recent. The oldest pre-Wisconsin drift, deposited by the Eklutna glacier, is exposed N. of the Eagle River Flats along the bluff of Knik Arm.

The youngest pre-Wisconsin glaciation, the Knik, is represented by sorted and unsorted drift that forms outwashes, moraines, deltaic, and glaciofluvial and ice-contact deposits. An associated blue-gray clay is of lacustrine or estuarine origin.

The Wisconsin glaciation, the Naptowne, is represented by sorted and unsorted drift that also form washes, moraines, and ice-contact deposits. Eo- n silt, derived from the outwash, is present lo- ly.

Undifferentiated glacial deposits and alluvial-fan osits may be Pleistocene or Recent in age. De- its of unequivocal Recent age include peat, mus- , dune sand, modern-channel and flood-plain al- ium, estuarine silts, and thin loess that blankets st other deposits.

Most of the deposits S. of Anchorage are related he Knik glacier. A warm climate preceded the ance of the Wisconsin Naptowne glacier. Strati- phic evidence suggests fluctuation of the Nap- ne glacier.

Materials are available for brick, subbase course, e course, surfacing, coarse aggregate, crushed regate, fill, ballast, soil binder, and agricultural e.

Foundation conditions range from excellent to r; some deposits, such as fine-grained till and , are susceptible to frost heaving.--Auth.

2218. Baylor Geological Society. FIELD CON- RENCE GUIDEBOOK: CRETACEOUS STRATIGRA- Y OF THE GRAND AND BLACK PRAIRIES, EAST- NTRAL TEXAS: 137 p., 16 pls. (2 fold. separate) l. maps, secs., Waco, Texas, Apr. 1960, refs.

This guidebook covers the fifth field conference of Baylor Geological Society, during which typical osures of mid-Cretaceous rocks were observed. book consists of 3 major sections: 1) road logs the 2-day field trip, p. 8-41; 2) 12 plates of meas- d sections, describing each of the stops, p. 42- 3) 16 short papers on the area, p. 55-136. The ers are listed below.

Muller, Daniel A. Physiography, p. 55-61.
Beall, Arthur. Sedimentary History of Central as, p. 62-64.
Silver, Burr. Structural Geology of McLennan nty, p. 65-67.
Taylor, Don R. The Cretaceous Section of Cen l Texas, p. 68-74.
Rodgers, R.W. Walnut Formation, p. 75-78.
Payne, William R. Comanche Peak Limestone, p. 81.
King, George L., Jr. The Edwards Limestone of tral Texas, p. 82-87.
Fox, W.J., and O.N. Hopkins, Jr. The George- n Limestone, p. 88-94.
Taylor, Don R. The Del Rio Formation, p. 95-97.
Taylor, Don R. The Buda Limestone, p. 98-99.
Morales, Gustavo. The Pepper Shale, p. 100-104.
Chamness, Ralph. The Eagle Ford Group, p. 105- .
Seewald, Kenneth O. Stratigraphy of the Austin lk, McLennan County, Texas, p. 110-117.
Beall, Arthur. The Taylor Formation, p. 118-124.
Rodgers, R.W. Terraces in McLennan County, 125-127.
Silver, Burr. Economic Geology of McLennan nty, p. 128-136.

219. Russell, William L. JACKSON GROUP, TAHOULA AND OAKVILLE FORMATIONS AND OCIATED STRUCTURES OF NORTHERN GRIMES JNTY, TEXAS. Guidebook for Annual Field Trip, ston Geological Society and Gulf Coast Section of M, May 14, 1960: 50 p., illus., maps, secs., uston, Texas], May 1960, 16 refs.

This field trip continues the study of the strati- phic section [Eocene-Miocene] in the general region of the Brazos River valley. The older rocks in this section have been examined during previous field trips of the SEPM and the Houston Geological Society. The chief aim of this field trip is to acquaint Gulf Coast geologists with the stratigraphy, structures, and geologic problems of northern Grimes County and to describe some of the well-exposed and readily accessible examples of these features. The microfossils of the Moody's Branch member of the Caddell formation have been used extensively for long distance correlation. With this exception, fossils are used in field mapping in this area in the same manner as a lithologic characteristic. Megascopic invertebrate fossils (chiefly pelecypods) are common in the Caddell shale and in the lower part of the Tuttle sandstone. They are of rare occurrence in the Yuma sandstone and in a thin-bedded, platy siltstone about 40 to 50 ft. above the base of the Whitsett formation. Some of the important members have no distinctive lithologic characteristics and must be recognized by their position in the stratigraphic section, or by the relation of their outcrops to the outcrops of known key beds. The problems of identifying these members where they are forced out of their normal position by structural irregularities are discussed and illustrated.

Among the structures of Grimes County which are examined are a salt dome, faults, "dikes" of various types, and areas of steep dips, some of which appear to be due to faulting, while others are probably of a superficial nature. Reverse drag occurs along many of the faults of the region. It consists of a steep dip into the fault plane on the downthrown side. True drag commonly occurs close to the fault plane. Sandstones along the fault planes of the region are in places cemented by opal so that they are resistant to erosion and form ridges. These are sometimes referred to as "dikes," though they are not intrusive. Examples of intrusive dikes [are] visited on the field trip.--Auth. foreword.

Road logs and papers are listed below:

Brief Geological History of Formations Studied on Field Trip, p. 5-6.
Road Log Between Navasota and College Station, Texas, p. 9-10.
Drake, Dennis A. Millican and Millican East Gas Fields, Brazos County, Texas, p. 11-12.
Road Log from Assembly Point at Texas A. & M. College, p. 16-18.
Smith, Fred E. The Moody's Branch Member of the Caddell Shale, p. 20-23.

2-2220. New England Intercollegiate Geological Association. STRATIGRAPHY AND STRUCTURE OF WEST CENTRAL VERMONT AND ADJACENT NEW YORK. Guidebook for the Fifty-First Annual Meeting of the New England Intercollegiate Geological Conference. Edited by E-an Zen: 85 p., maps, secs., diags., Rutland, Vermont, Oct. 1959, refs.

The conference took place Oct. 17-18, 1959. The guidebook contains introduction and road logs for the following 10 trips:

Trips A and I. Stratigraphy and Structure at the North End of the Taconic Range and Adjacent Areas, p. 1-16.
Trip B. Excursions at North End of the Taconic Range Near Sudbury, p. 17-18.
Trip C. Stratigraphy of the Central Champlain Valley, p. 19-34.
Trip D. Geology of the Marble Deposits Near Rutland, p. 35-41.
Trip E. Economic Geology of Slate, p. 43.

Trip F. Stratigraphy and Structure of the Coxe Mountain Area, Vermont, p. 45-51.

Trip G. Pt. 1. Stratigraphy and Structure of the Taconic Sequence in the Thorn Hill and Granville Quadrangles; Pt. 2. Pawlet Quadrangle; Pt. 3, Graptolite Faunas of the Northern Part of the Taconic Area, p. 53-69.

Trip H. Stratigraphy and Structure in the Vermont Valley and the Eastern Taconics Between Clarendon and Dorset, p. 71-85.

2. GEOMORPHOLOGY

See also: Geologic Maps 2-2199, 2-2200, 2-2201; Areal and Regional Geology 2-2212, 2-2214, 2-2217; Mineralogy 2-2355.

2-2221. Meier, Mark F. **MODE OF FLOW OF SASKATCHEWAN GLACIER, ALBERTA, CANADA:** U.S. Geol. Survey, Prof. Paper 351, 70 p., 9 pls. incl. 9 illus., 3 maps (in pocket), 2 profiles (in pocket), 48 figs. incl. illus., maps, secs., diags., graphs, 11 tables, 1960, 79 refs.

Research in 1952-1954 on Saskatchewan Glacier was directed toward the measurement of velocity on the surface and at depth, the surface and bedrock topography, ablation, and structures produced by flow. These field data are used to test current theories of flow and to derive new conclusions about the flow of a valley glacier.

Positions in space of 51 velocity stations fixed in the ice were computed from triangulation surveys. Summer velocities are generally greater than yearly velocities. Short-interval (1/2-1 day) observations recorded great velocity fluctuations and intermittent backward movements. Some of these fluctuations represent domains not more than 100 ft. in extent. Dispersion values indicate that jerky motion is probably due to irregular shearing and is not predominantly perpendicular to crevasses. Dispersion of velocity decreases with increasing time intervals of measurement. Maximum surface velocity of 383 f.p.y. (feet per year) occurs at the firn limit; velocity decreases unevenly along the midglacier line to 12 f.p.y. at the terminus. Velocity vectors plunge below the surface along the centerline from above the firn limit to 1.3 mi. below. Further downglacier the vectors rise out from the surface and the angular divergence increases both downglacier and toward the margins. The flow of ice toward the surface is constant at 10 f.p.y. in the lower 3 mi. Rates of surface lowering computed from these data and ablation data agree approximately with independently measured thinning.

Velocity gradients in an area of detailed study are analyzed to determine the surface strain-rate field. Deformation is largely caused by the transverse gradient of the longitudinal velocity. Longitudinal and transverse extensions and compressions were measured. One principal strain-rate trajectory lies along the flow centerline; a trajectory of maximum shearing strain rate parallels the valley wall at the margin.

Velocity to a depth of 140 ft. decreases exponentially. The flow law of ice is determined by an analysis of this short vertical profile and a transverse velocity profile on the surface. The 2 sets of data give consistent results which agree with results from other glaciers, and suggest that the flow law is unaffected by either hydrostatic pressure or extending or compressing flow. The strain rate cannot be expressed as a simple power function of the stress. A viscouslike flow seems to predominate at low stresses. Above a shear stress of 0.7 bar the flow velocity changes much more rapidly with slight changes in stress.

The derived flow law is used to compute velocity as a function of depth and the mass-budget. These results show that the ice currently being supplied to the surface is not as great as the surface ablation but is just sufficient to keep the glacier thinning at an unchanged rate in time. Computed streamlines parallel the bedrock channel closely.

Three main classes of features in the ice are distinguished: 1) primary sedimentary layering, 2) secondary flow foliation, and 3) secondary cracks and crevasses. Primary stratification is flatlying in general but wrinkled longitudinally in detail. Foliation generally dips steeply, strikes longitudinally, and shears other structures. However, some foliation attitudes do not relate to measured directions of maximum shearing strain rate at the point of observation or at any conceivable point of origin. The orientation of the most prominent set of cracks agrees approximately with measured trajectories of principal compressing strain rate. Other minor sets of cracks are related to trajectories of maximum shearing strain rate.--Auth.

2-2222. Stalker, Archibald M. **ICE-PRESSED DRIFT FORMS AND ASSOCIATED DEPOSITS IN ALBERTA:** Canada, Geol. Survey, Bull. 57, 38 p., 13 illus (4 in pocket) 5 secs., 1960, 16 refs.

The various forms of "ice-pressed" features that occur in the Pleistocene deposits of Alberta are described, and a general explanation of their origin is given. The significance of the forms in the history of deglaciation and their relation to the large hummocky moraines of the prairies are also briefly discussed.

These features, which are to be expected in any hummocky moraine in any area where ice stagnation and suitable material occurred, were formed during retreat of the last glacier in broad, marginal belts of the ice sheet and also where the ice was thin over high land. This indicates that the sub-glacier material probably was not frozen during this stage of deglaciation.

It is concluded that these features were formed by a process of pressing or squeezing of sub-ice material into nearby tunnels, holes and crevasses in the ice sheet.

Moraines of Alberta may represent changes in rate of, or halts in the lowering of the surface of the ice sheet and should be correlated by altitude rather than by position.

The various ice-pressed forms are illustrated by a comprehensive selection of air and ground photographs.--Auth.

2-2223. Putnam, William C. **ORIGIN OF ROCK CREEK AND OWENS RIVER GORGES, MONO COUNTY, CALIFORNIA:** California, Univ., Pub. Geol. Sci., v. 34, no. 5, p. 221-280, 16 illus., 3 maps (geol. map in pocket), secs. (in pocket), profiles, 1960, 28 refs.

Owens River and Rock Creek now follow subparallel courses in deep gorges cut across a plateau of late Pleistocene rhyolitic pumice and tuff immediately

of the central Sierra Nevada.
The accumulation of tills of 3 glacial stages, which
order of decreasing age are the Sherwin, Tahoe,
d Tioga, in addition to more than 500 ft. of pumice
d tuff, blocked the drainage of most of the streams
this region on the eastern slope of the Sierra Ne-
da. Faulting has also been active here throughout
e Quaternary, and, together with warping, was
sponsible for the uplift of the Sierra Nevada, as
ll as the depression of the neighboring basin of
ng Valley.
This valley was occupied by a large lake, presum-
ly during the latter part of the Pleistocene, which
as drained through capture resulting from the head-
rd growth of the Owens River across the blanket
rhyolitic tuff covering the volcanic tableland. The
ens Gorge very likely was excavated to its pres-
t-day depth as a consequence of the greatly in-
eased flow of the Owens River resulting from this
pture.
Rock Creek, which had formerly drained north-
rd to Long Valley, was captured at a somewhat
ter date, and also by headward growth of a stream
llowing a course roughly parallel to the Owens
ver, with the result that its gorge was eroded to
s depth of today, partly as a consequence of greatly
hanced discharge.--Auth.
Appendix: Engineering geology of Tunnel No. 1,
ens Gorge project.

**2224. Folks, Homer C. PHYSICAL AND MIN-
RALOGICAL PROPERTIES OF PLEISTOCENE(?)
RFICIAL DEPOSITS IN THE UPPER COASTAL
LAIN OF NORTH CAROLINA: Southeastern Geology,
1, no. 4, p. 147-153, 2 tables, Apr. 1960, 12 refs.**

To evaluate the hypothesis, Pleistocene deposits of
e Coastal Plain in North Carolina above an elevation
100 ft. are fluvial in origin and have arisen through
working of the underlying sediments, samples were
llected for analysis from sandy deposits at differ-
t elevations. From data obtained through mechan-
al and mineralogical analyses, it was concluded that
e Pleistocene(?) surficial deposits of the Coastal
ain are fluvial in origin and that they have arisen
rough a reworking of the underlying sediments.
creased sorting occurs from the higher elevations
the lower elevations and also sorting occurs within
evational regions from the ridges to depressional
eas. These 2 factors indicate that local sorting
s occurred and is a major factor in the evolution
the Coastal Plain landscape. The mineralogical
ites found in the surficial deposits at different
cations are conspicuously uniform in nature. These
ites are in turn very similar to those of the under-
ing sediments as has been reported by other inves-
gators.--Auth.

**2225. Salt Marsh Conference, Marine Institute,
pelo Island, Georgia, 1958. PROCEEDINGS: 133
, 16 figs. incl. illus., secs., diags., graphs,
bles, Athens, University of Georgia, Apr. 1959,
efs.**

The conference was held March 25-28, 1958, at
e Marine Institute of the University of Georgia. The
udy of salt marshes is an interdisciplinary subject;
stinctive land forms have been produced by a com-
nation of geological processes and biological activ-
ies working under the control of changing sea levels.
n analogy is drawn between salt marshes and coral
eefs. Comparatively little study has been made of
lt marshes. The purpose of the conference was to advance the recognition of salt marshes as a coherent subject for general scientific study and to clarify the role of each discipline in contributing to an understanding of the phenomena as a whole.--From introd.

Contents are as follows; discussions follow each paper.

PT. I. SALT MARSHES AS LAND FORMS.

Steers, J. A. The physiography of salt marshes, p. 3-8.

van Straaten, L. M. J. U. Origin of Recent Dutch tidal flat formations, p. 9-21.

Ragotzkie, Robert A. Drainage patterns in salt marshes, p. 22-28.

Russell, Richard J. Alluvial morphology of Louisiana salt marshes, p. 29-31.

Morgan, James P. Coastal morphological changes resulting from hurricane "Audrey," p. 32-36.

Redfield, Alfred C. The Barnstable marsh, p. 37-42.

Stevenson, Robert E. The sedimentary environment at Newport Bay, California, p. 43-44.

Zeigler, J. M. Comments on the geologic history of the sea islands of the southeastern United States, p. 45.

PT. II. SALT MARSHES AS VEGETATION.

Chapman, V. J. Relationships of salt marsh vegetation, p. 47-57.

Moul, Edwin T. Ecological observations of pools in the salt marshes of New Jersey, p. 58-68.

Scher, Stanley, and Edwin T. Moul. Nutritional factors in salinity and temperature tolerance of some phytoflagellates, p. 69.

Burkholder, Paul R. Some microbiological aspects of marine productivity in shallow waters, p. 70-75.

PT. III. THE SALT MARSH AS AN ECOSYSTEM.

Redfield, Alfred C. Circulation of heat, salt, and water in salt marsh soil, p. 77-87.

Pomeroy, Lawrence R. Productivity of algae in salt marshes, p. 88-95.

Smalley, Alfred C. The growth cycle of Spartina and its relation to the insect populations in the marsh, p. 96-100.

Teal, John M. Energy flow in the salt marsh ecosystem, p. 101-107.

PT. IV. SALT MARSHES AS HISTORICAL RECORDS.

Barghoorn, Elso S. Paleobotanical studies in salt marsh deposits with special reference to recent changes in sea level, p. 109-113.

Vallentyne, J. R. Some aspects of the biochemistry of mud, p. 114-115.

Raup, Hugh M. Archaeology and salt marsh problems in the Taunton River valley, Massachusetts, p. 116-118.

Johnson, Frederick. Archaeology and salt marsh problems in Massachusetts, p. 119-121.

Schafer, W. Elements of actuo-paleontology, p. 122-125.

Hantzschel, Walter. Trails and burrows on the tidal flats of the North Sea and their paleontological significance, p. 126-133.

2-2226. THE CASCADIA CHANNEL: Naval Research Rev., Feb. 1960, p. 19-20, chart.

A 1,500 mi. long, 1,000 ft. deep channel runs W. across the Pacific Ocean from Oregon. A description of the channel is given; it is 5 to 10 times larger than the Mississippi River channel. It was presumably cut by turbidity flows during the Pleistocene.--R. F. McAllister.

2-2227. Lacombe, H. QUELQUES TRAITS REMARQUABLES DU RELIEF SOUS-MARIN EN MER MEDITERRANÉE ET EN MER NOIRE [SOME REMARKABLE FEATURES OF THE FLOOR OF THE MEDITERRANEAN SEA AND OF THE BLACK SEA]: Deep-Sea Research, v. 6, no. 3, p. 211-216, 2 illus., 3 maps, profile, Apr. 1960, 2 refs.; abs. in English, text in French.

Presented here are a few remarkable features of the floor in the Mediterranean and Black seas, from soundings obtained in July and Aug. 1955, on board the Calypso, under command of Cdr. J.Y. Cousteau. These soundings show the existence of depths of 5,000 m. in the Ionian Sea, S. of continental Greece, and of ripples reaching 40 m. in height in regular depths of 1,900 m. in the southern Black Sea, off the Bosporus.--Auth.

2-2228. Hayter, P.J.D. THE GANGES AND INDUS SUBMARINE CANYONS: Deep-Sea Research, v. 6, no. 3, p. 184-186, 3 maps, Apr. 1960, ref.

Details are shown of the topography of the sea floor near the heads of the Ganges and Indus submarine canyons.--Auth.

2-2229. Fernald, Arthur T. GEOMORPHOLOGY OF THE UPPER KUSKOKWIM REGION, ALASKA: U.S. Geol. Survey, Bull. 1071-G, p. 191-279, 10 illus., 5 maps (2 col. geol. maps, scale 1:250,000, in pocket), chart, sec., 4 diags., 4 graphs, 1960, 41 refs.

The upper Kuskokwim region as described in this report covers an area of about 6,000 sq. mi. in SW.-central Alaska, and includes a small section of the Alaska Range, its bordering piedmont and lowland, and an adjacent upland area. It is drained by the upper part of the Kuskokwim River, which originates from the convergence of its several major tributaries in the lowland area. The region is underlain by sedimentary rocks of Paleozoic and of Cretaceous age and igneous rocks of Tertiary age. Most of the region, including large parts of the uplands and mountains, is covered with surficial deposits of several types - colluvial, glacial, eolian, alluvial, and organic material.

An extensive erosion surface formed over part of the region during the late Tertiary. This surface was differentially uplifted, probably in the late Pliocene or early Quaternary, and now covers upland summits at an altitude ranging from 1,000 to 2,000 ft. above sea level. Rejuvenated streams following the uplift carved out innumerable valleys within the uplands, and the ancestral Kuskokwim River, which probably flowed on the erosion surface in about its present position, cut a broad canyon through the uplands. The Alaska Range was probably uplifted at the same time, and has undergone continued uplift during the Quaternary. Differential movement is still going on along 2 large faults, the Farewell fault at the N. edge of the Alaska Range, and the Nixon Fork fault within the uplands.

Much of the lowland area, where debris derived principally from the rising Alaska Range has accumulated to an unknown thickness, has subsided, probably during the Quaternary. This wedge of sediments has pushed the Kuskokwim River to its present position along the N. edge of the lowland.

Climatic fluctuations during the Pleistocene gave rise to repeated glaciations in the Alaska Range, where glaciers scoured large U-shaped valleys and also spread out onto the bordering piedmont. These fluctuations influenced the erosion and deposition in the nonglaciated areas. In the lowland, the accumulation of fluvial and eolian deposits was accelerated during the glacial advances. In the uplands, which were for the most part unglaciated, the zone of intense frost action, now at about 2,000 ft. and above, was lowered during the glacial advances. Coarse rubbly colluvium is characteristic of this zone, and the rubble at the base of some of the creek valleys was probably deposited during the glacial climates; in other valleys the material was reworked by streams into well-rounded gravel. Present streams in the valleys, which are partially filled with organic material and silt over the rubble and gravel are sluggish and clogged with vegetation.

Two major glaciations of late Quaternary age are recorded by 2 sets of moraines in each of 3 areas on the piedmont; the moraines were deposited by glaciers that originated within the Alaska Range and extended down the valleys of the Big River and the Windy Fork and the South Fork of the Kuskokwim River. The older, or Selatna, glaciation is of Wisconsin(?) age, and is represented by greatly subdued moraines at maximum distances of 18, 12, and 25 mi., respectively, from the base of the mountains. It is also represented by an outwash slope in the Big River area. The younger, or Farewell, glaciation is represented by generally fresh to slightly subdued moraines at maximum distances of 0, 8, and 20 mi., respectively, from the mountains, and by widespread outwash slopes in the Windy Fork and South Fork areas. This glaciation is of Wisconsin age, and is divisible into an early phase (Farewell 1) and a late phase (Farewell 2).

The Farewell glaciation was accompanied by a period of maximum eolian activity in which loess was deposited over much of the region and dune sand was deposited over a large part of the lowland. Long arcuate ridges of sand that are oriented northeastward, with the concave side to the SE. and the steeper slope to the NW., are the most conspicuous dune type. They belong to the phytogenic class of dunes, and were formed principally by SE. winds but modified by southerly and, probably, SW. winds. Some of the dunes became stabilized only in fairly recent time, and comparatively small amounts of loess are still being deposited. Remnants of old dune fields in the western part of the region are probably related to the Selatna glaciation.

The present surface deposits of the piedmont and lowland areas, other than the glacial and eolian sand deposits and a widespread veneer of organic and loessal material, are those of several alluvial features. The modern rivers, braided on the piedmont and meandering in the lowland, have formed narrow flood plains and large fans on the piedmont and broad meander plains in the lowland; tributary rivers in the lowland have formed small fans after emerging from the uplands. Rivers have also formed 2 older plains in the lowland, widespread fan aprons at the base of the uplands, and cones at the base of the Alaska Range. The deposits encompass several age spans within the late Quaternary.

A widespread cover of organic material, largely peat, is accumulating today over much of the lowland, parts of the piedmont, and locally within the uplands; similar material probably accumulated widely in the interval between the Selatna and Farewell glaciations. The modern peat is found below living muskeg vegetation, where permafrost is generally present at depths of 1 1/2 to 3 ft. Peat also is found in bogs, which are interspersed within the areas of muskeg vegeta-

n and are so numerous in poorly drained parts of
flatlands that they cover a fourth or more of the
rface. A cyclic formation of permafrost below muskeg vegetation and its melting in bogs apparently goes on continuously. Completely undrained parts of the flatlands contain many large lakes.--Auth.

3. STRUCTURAL GEOLOGY

also: Geophysics 2-2269; Fuels 2-2441, 2-2442,
443, 2-2445.

2230. Bascom, Willard. **PLANS FOR DRILLING
E MOHOLE:** Alberta Soc. Petroleum Geologists,
ır., v. 8, no. 3, p. 88-89, March 1960.

Plans for drilling the mohole have advanced to the
int where drilling of 3 test holes "for practice"
ar Guadalupe Island off the coast of Baja California
ve been scheduled to commence in 1960. They are
imated to cost one million dollars. Based on the
perience of this drilling program, final designs
the equipment to drill the necessary 30,000 ft. to
Mohorovičić discontinuity will be made. The ulti-
ate cost of drilling is expected to be about $15,000,000.
M. Russell.

2231. **MOHOLE DRILLING TESTS:** Sci. News
tter, v. 78, no. 3, p. 47, July 16, 1960.

The present status of a project to drill an explora-
y hole to and through the Moho [Mohorovičić dis-
ntinuity], is very briefly summarized; its history,
rpose, and progress are reviewed. Interest in an
ea within which to drill has centered in a 40-sq.
. area off Guadalupe Island in the Pacific off Mexi-
--M. Russell.

2232. MacCarthy, Gerald R. **THE FORMATION
JOINTS AS A POSSIBLE CAUSE OF CERTAIN
ISMIC PHENOMENA:** Southeastern Geology, v. 1,
4, p. 117-119, Apr. 1960, 5 refs.

Computations of the order of magnitude type indi-
e that sufficient elastic energy may be liberated
ring the formation of major joints to produce such
rypto seismic" effects as light localized earth
emors, underground rumbling sounds, and the like.
Auth.

2233. Jones, W.R., Joe W. Peoples, and Arthur
Howland. **IGNEOUS AND TECTONIC STRUC-
RES OF THE STILLWATER COMPLEX, MON-
NA:** U.S. Geol. Survey, Bull. 1071-H, p. 281-
, 9 illus., 2 geol. maps (in pocket), secs. (1 in
cket), 1960, 58 refs.

Igneous structures. An upturned and previously
veled edge of the Stillwater complex, a Precam-
ian stratiform sheet about 18,000 ft. thick and com-
ising a sequence of noritic and ultramafic rocks
d chromite layers, crops out in a belt 30 mi. long
the NE. margin of the Beartooth Mountains in Mon-
na. According to the scheme of subdivision used
this paper, the complex consists of the following
zones from bottom to top: a) the Basal zone, 200 ft.
ck, medium-grained noritic rocks; b) the Ultra-
afic zone, 4,000 to 6,000 ft. thick, a succession
layers of bronzitite, granular harzburgite, poiki-
ic harzburgite, and chromitite; c) and d) the
nded and Upper zones, in aggregate 14,000 ft. thick,
yers of norite, anorthosite, troctolite, and gabbro.
e position of the contact between the Banded and
per zones is in doubt because of uncertainty in
eral correlation of several troctolite layers. The
cks of the Ultramafic zone are easily distinguished from those of the Banded and Upper zones; however, the nature of the upper contact of the Ultramafic zone is uncertainly known in some places. Local discordances at that contact are probably the result of deformation after consolidation of the complex, but possibly they resulted from deformation during crystallization.

Layers within the major zones exhibit 2 types of primary structures: igneous lamination and rhythmic layering. Lamination, a function of the platy habit of the clinopyroxene, orthopyroxene, and plagioclase, is most frequently observed in the upper part of the Banded zone and in the Upper zone. Rhythmic layering, involving variations in mineral composition or mode and in texture, is more conspicuous in the Banded and Upper zones but is also common in the Ultramafic zone.

Rhythmic layers range greatly in thickness from a fraction of an inch to hundreds of feet. Many thin layers appear to branch and, farther on, to coalesce, forming primary lenses concave upward in the columnar section. All the layers are truly lenses, ranging from minute to large lenses thousands of feet long. Where the curvature of the lens is great, a primary basin or trough is formed. Such structures involving chromitite layers may be of economic significance, for detailed mapping will reveal trends in thickening and thinning. In primary basins, individual layers thicken toward the axis of the trough.

Irregularities in the trend of certain layers and groups of layers are believed to be due to movements before crystallization had been completed. Irregularities were observed in norite layers, and in the upper boundaries of some troctolite layers.

Tectonic structures and igneous activity. Before Middle Cambrian time the metasedimentary rocks beneath the complex had been locally displaced by granite, and the complex may have been arched within an ancestral range. Diabase intruded the granite, the metasedimentary rocks, and the Stillwater complex, forming sills, dikes, and small irregular masses. Erosion, accelerated by the uplift, beveled the arched crustal block, exposing its core of granite, metasedimentary rocks, and an edge of the Stillwater complex. During Paleozoic and Mesozoic times, the Precambrian erosional surface was buried beneath 8,000 to 10,000 ft. of sedimentary rocks, predominantly limestone deposited during the Paleozoic era, and sandstone, shale, and volcanic breccia deposited during the Mesozoic era.

Throughout the Paleozoic and most of the Mesozoic, the area was part of a structural shelf that underwent slow epeirogenic movements with little, if any, attendant igneous activity. The absence of rocks of Silurian, Late Pennsylvanian, and Permian age in this locality indicates intervals of uplift and consequent erosion or nondeposition.

Forces of the Laramide orogeny greatly deformed the upturned edge of the complex and the overlying strata. During the early phase of the orogeny, deep-seated thrust and ramp faults dipping northeastward developed in the crystalline basement near the present mountain front. At the same time folds, overturned to the SW., developed in the sedimentary strata, commonly as the near-surface expression of the NE.-dipping faults and of layering-plane adjustments. Movement on the ramp thrust increased the NE. tilt of the layers in the elevated blocks only 15° to 20°. Most of the deformation visible today is attributed to deformation in a later phase of the Laramide orogeny. The ends of the Stillwater complex, especially the eastern end, appear to have been twisted. The steep and overturned igneous layers, and major swings in their trend, are evidence of great rotational strain along segments of the mountain front where SW.-directed forces met massive resistance. In the eastern part of the complex, S.-dipping thrusts eventually developed, breaking across the steepened layers and the related tight fold of the sedimentary blanket. Thrusts of the earlier phase, warped and steepened, are recognizable in the rotated sections of the complex. The attitudes of Precambrian diabase dikes in rotated blocks are also greatly changed from their original attitude. The Lake-Nye Creek fault developed along a diabase dike which probably dipped N. originally, but which now stands vertical in one place and dips 60° S. in another.

Absence of Cenozoic strata in the Stillwater area precludes evaluating the extent of post-Laramide adjustments. Laramide structures may have been reactivated when the region underwent epeirogenic movements.--Auth.

2-2234. Hill, M.N. A MEDIAN VALLEY OF THE MID-ATLANTIC RIDGE: Deep-Sea Research, v. 6, no. 3, p. 193-205, 2 illus., 2 maps, 3 charts, 2 profiles, Apr. 1960, 14 refs.

A median valley of the Mid-Atlantic Ridge at least 75 mi. in length running in a N.-S. direction is described. Its bottom lies at a depth between 1,800 and 2,200 fm. and the flanks rise steeply to between 900 and 1,200 fm. The width between the flanks is approximately 12 mi.

No direct evidence of the rock types in the area is available but the seismic evidence suggests the existence of basaltic lavas on the flanks. Evidence for present-day volcanic activity in the area comes from a measurement of the heat flow through the floor of the valley; this was about 6 times higher than is usual in deep sea or continental areas.

The valley was not associated with any large magnetic anomaly; it is, however, possible that its axis corresponds with the line of earthquake epicenters through the area.--Auth.

2-2235. Odell, Noel E. THE BUILDING OF MOUNTAINS: Am. Alpine Jour., v. 12, no. 1, p. 87-94, 1960.

A summary of the more significant theories of the origin of mountains and the workers and schools of thought which have held forth. European geologists in explaining the origin of the Alps emphasized the role of sedimentary basins and subsequent directed pressures. Study of the Appalachians clarified the concept of folded mountains. Great overthrusts were recognized in studying the structure of the Scottish highlands and the mountains along the Norwegian-Swedish border. The Rockies exhibit examples of block mountains and large igneous intrusions. No completely adequate explanation of mountain building exists for all mountains, yet there are many concepts such as isostasy, continental drift, subcrustal convection currents, and others which are useful in leading to an understanding of a tremendously complex process.--M. Russell.

2-2236. Chamberlain, J.A. STRUCTURAL HISTORY OF THE BEAVERLODGE AREA: Econ. Geology, v. 55, no. 3, p. 617-618, May 1960, 4 refs.

Reply to a discussion by P.A. Hill of a paper by J.A. Chamberlain (GeoScience Abstracts 2-311). [The Beaverlodge area is in Saskatchewan, Canada]. Right-hand fault movements of 1,000 to 1,200 ft. as described by Hill are apparent movements based on the separation between doubtfully equivalent Tazin [Precambrian] rocks along lineaments of uncertain or unknown dip. True movements are probably on the order of 150 ft.--Auth.

2-2237. Dietrich, Richard V. BASEMENT BENEATH THE EMERGED ATLANTIC COASTAL PLAIN BETWEEN NEW YORK AND GEORGIA: Southeastern Geology, v. 1, no. 4, p. 121-131, 2 maps, sec., Apr. 1960, 31 refs.

Basement is defined, for the purposes of this article, as the metamorphic and/or igneous rocks below which there is no known stratigraphic or structural break.

At least 500 holes have penetrated basement beneath the Mesozoic and Cenozoic sediments of the Atlantic Coastal Plain between New York and Georgia. Approximately 90% of them penetrated basement at elevations higher than -1,000 ft. M.S.L. The 10,054-ft. Esso #1 Hatteras Light well, which encountered the top of basement at -9,954 ft. M.S.L., is deepest.

Drill hole and geophysical data support the following tentative conclusions: 1) Basement rocks are Precambrian and Paleozoic metamorphic and igneous (including volcanic) rocks, similar to those exposed on the Piedmont to the W. Many of these rocks have been highly fractured and sheared. 2) Part of the rocks accumulated in a Pre-Mesozoic eugeosyncline. 3) Since at least late Mesozoic time the basement surface has been a differentially warping platform. 4) At least 4 periods of diastrophism are known to have affected the basement of this area. 5) The regional structural (and topographic) trend is NE-SW. 6) The surface of the basement is an old age erosion surface - commonly referred to as the Fall Zone peneplane - with sporadic fault troughs, ridges, valleys, and "arches." 7) Locally some of the rocks have been weathered to depths exceeding 150 ft. 8) The basement surface dips generally seawardly about 15 to 45 ft./mi. (with about 35 ft./mi. typical) to approximately the -2,400-ft. M.S.L. contour and seaward from this contour it steepens to about 100 to 125 ft./mi.

Oil may possibly occur in commerical quantities in weathered zones on or fractured zones in the basement, or in sedimentary rocks that lens out against topographic highs of the basement surface.--Auth.

2-2238. Ferenczi, István. STRUCTURAL CONTROL OF THE NORTH CAROLINA COASTAL PLAIN: Southeastern Geology, v. 1, no. 3, p. 105-116, map, Autumn 1959, 34 refs.

The North Carolina Coastal Plain is not a simple homoclinal structure. The great Carolina ridge is an area of uplift and the Hatteras axis is one subsidence; both are transverse to the Appalachian trend. Midway between those 2 features is the Cape Lookout-Neuse fault zone, also transverse to the Appalachians. Several data in the literature suggest a fourth structural feature, a to date unnamed fault zone with a trend parallel to the Appalachians. As a possible fifth feature, a "zone of subterranean disturbance," suggested by Shaler, 1871, but not proved to date, is mentioned. In conclusion it is suggested that the capes along the present shoreline ve been controlled by these structural features. The basement rock beneath the sedimentary cover s the character of peneplained block mountain ther than that of a folded mountain chain.--Auth.

2239. Melik-Barkhudarov, K.B., and G.G. mikyan. ON THE STRUCTURE OF THE ALYAT DGE: Geologiya Nefti - Petroleum Geology [in anslation], v. 2, no. 11-A, p. 946-948, 1958, [pub. 60], 11 refs.

The main controversial opinions on the complicated ructure of the Alyat ridge [southeastern Caucasus] e briefly exposed. The authors agree with earlier vestigators in explaining the brecciation of the igocene and the disturbances and apparent reduc- on in thickness of the Pliocene deposits by a com- nation of diapiric folds and a major fault. The esence of a thick cover of mud breccia adds to the mplexity of the picture. Gravity data show a minium regional gravity anomaly, indicating relative bsidence of the Mesozoic in this area and develop- ent of a very complete section of Tertiary sediments in this region.--C. Voûte.

2240. Mikhailova, N.G. ON THE SOURCE DATA ED IN THE PAPER "GEOLOGY AND OIL PROS- CTS OF THE NORTHERN BLACK SEA AREA AND RTHWESTERN AZOV SEA AREA": Geologiya fti - Petroleum Geology [in translation], v. 2, no. -B, p. 988-989, graph, 1958, [pub. 1960], ref.

It is briefly stated that the schematic structure ap of the surface of the basement, published by .S. Burshtar and I.F. Klitschenko in Geologiya efti, no. 10, 1957, cannot be considered as correct. is map was based on seismic data. A critical alysis of the seismic records reveals that the ma- rity of waves, registered as waves reflected from e surface of the Upper Cretaceous or from deeper flecting horizons, have effective velocities lower an those established by seismic logging. It is sug- sted that these waves are multiples and that the ructural map of the area was constructed on non- istent horizons.--C. Voûte.

2241. Trushkin, P.G. THE STRUCTURAL RE- ATIONS OF THE MESOZOIC AND PALEOZOIC RMATIONS IN THE SOUTHEASTERN KUYBYSHEV TRANS-VOLGA REGION. Translated by Walter S. White: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 12-A, p. 1018-1025, map, profile, 1958, [pub. 1960], 8 refs.

A brief description of the regional geology and structures. Faulting, advocated by earlier authors, has not been confirmed during recent investigations and drilling operations. Mesozoic strata lie unconformably on the Paleozoic. The Mesozoic sequence is not complete; parts of the Jurassic and Cretaceous are missing. As a result of transgressive deposition of the Mesozoic on the various stages of the Paleozoic, a flat depression is found in the Mesozoic which is not reflected in the structure of the Permian strata. The general plan of the tectonic structures of the Mesozoic, with several zones of uplifts, repeats the structural plan of the upper Permian and has the same northwesterly direction. However the Mesozoic structural zones rise to the SE. and the upper Permian to the NW. The Mesozoic structures have more subdued outlines than those of the Paleozoic.--C. Voûte.

2-2242. Viktorov, B.N. SOME FEATURES OF THE GEOLOGY OF THE PRI-KUMA REGION OF THE EASTERN CIS-CAUCASUS: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 11-A, p. 937-942, map, 2 figs., 1958, [pub. 1960], 7 refs.

Seismic surveys and drilling have indicated the presence of about 30 buried Mesozoic uplifts, lying along 5 definite, slightly curving lines. It has been possible to trace the structures on several horizons. Thus it has become clear that the folding of the Mesozoic formations in this area appears to be inherited from the basement folding, in this case strongly folded and metamorphosed Carboniferous. In the eastern part of the area the folding of the basement and of the overlying deposits was completed in early Cretaceous time, and younger sediments were not affected by them. In the western regions this process lasted longer, embracing all the Mesozoic and part of the Paleocene. Additional uplifts might be expected either along the lines in between some of the structures already discovered, or on their westward and eastward continuation. In the E., oil deposits should be expected first in the older part of the sediments. In the Stavropol area not only the Mesozoic but also the lower part of the Paleocene might contain accumulations.--C. Voûte.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

e also: Areal and Regional Geology 2-2216, 2-2218, 2219; Structural Geology 2-2237; Paleontology 2-2253, 2254, 2-2255, 2-2258, 2-2259.

2243. Sinclair, G. Winston. SUCCESSION OF RDOVICIAN ROCKS IN SOUTHERN MANITOBA: anada, Geol. Survey, Paper 59-5, 9 p., map, 4 bles, 1959, 14 refs.

The Selkirk and the Dog Head members of the Red iver formation, as currently understood, are be- eved to be equivalent and to underly the Cat Head ember. The Red River is now considered to consist 2 members, an upper cherty, dolomitic unit (Cat ead), and a lower fragmental unit (Dog Head).--Auth.

-2244. Belyea, Helen R. DEVONIAN ELK POINT ROUP, CENTRAL AND SOUTHERN ALBERTA: Canada, Geol. Survey Paper 59-2, 14 p., map (in pocket), 2 secs. (in pocket), 1959, 19 refs.

Elk Point formation was proposed in 1949 as a subsurface term for a variable sequence of beds between dolomites of Ordovician age and the carbonate-shale sequence of late Middle or Upper Devonian age in central and southern Alberta. Nine informal members were later recognized by Crickmay in the "evaporite basin" of Elk Point sedimentation, and subsequently grouped by Van Hees into lower Elk Point comprising salt, red shale, anhydrite and siltstones, and upper Elk Point, more extensive than the lower unit, and comprising dolomite, limestone, silt and anhydrite. All the Elk Point was originally assigned to the Middle Devonian. Some discussion has arisen over the age of the lower Elk Point, but no further evidence of age for these is presented. Trends in the basin are discussed together with their possible bearing on the development of Upper Devonian reefs. --P. Harker.

2-2245. Raznitsyn, V.A. THE BOUNDARY OF THE DEVONIAN AND THE CARBONIFEROUS IN SOUTH TIMAN: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 10-B, p. 884-889, map, 1958, [pub. 1960].

The boundary between the Devonian and the Carboniferous and the attribution of the Dzhebol substage in both its terrestrial and carbonate facies to the Tournaisian (lower Carboniferous) are discussed mainly in terms of brachiopod assemblages. Some foraminiferal assemblages are also mentioned from the lowermost Carboniferous of this area. Changes of facies in the lower Carboniferous are also mentioned, and their implication on the stratigraphic nomenclature and paleogeography of the lower Carboniferous is stated. Comparisons are made with the lowermost Carboniferous fauna in the southern Urals (Lytven limestones), Kazakhstan, Armenia (Etren beds), and western Europe (Etroeungt zone). --C. Voûte.

2-2246. Eargle, D. Hoye. STRATIGRAPHY OF PENNSYLVANIAN AND LOWER PERMIAN ROCKS IN BROWN AND COLEMAN COUNTIES, TEXAS: U.S. Geol. Survey, Prof. Paper 315-D, p. 55-77, 7 illus., 3 maps (1 in pocket), chart (in pocket), sec. (in pocket), table, 1960, 42 refs.

Rocks of Pennsylvanian and early Permian age crop out in a roughly triangular area in the Colorado River valley in central Texas, immediately N. of the Llano uplift. The apex of this triangular area is about 70 mi. NW. of Austin; its base trends NNE. from an overlap of Lower Cretaceous rocks near Brady to another overlap of Lower Cretaceous rocks that lies along the divide between the Colorado and Brazos River valleys. Brownwood and Coleman are the 2 largest cities in or near this area.

Only outcropping rocks of Middle Pennsylvanian to early Permian age are considered in this study. The Pennsylvanian rocks belong to 3 groups - Strawn, Canyon, and Cisco. The Permian rocks belong to the lower part of the Wichita group. The beds dip gently WNW. about 50 to 80 ft. to the mile. Of these rocks, only those of the lower part of the Strawn group are appreciably disturbed by folding or faulting in the Colorado River valley. The limestone beds generally occupy the tops of cuestas whose back slopes are dip slopes slightly truncated by erosion. The shale and thin sandstone beds are less resistant to erosion than the limestone and occupy the frontal slopes of the cuestas and the valley bottoms. Thick beds of sandstone or conglomerate also locally form cuestas.

Rocks of the Strawn group in Brown and Coleman counties are probably the equivalents of thicker deposits to the NE., E., and SE. in the Fort Worth basin and the Ouachita geosyncline. Although a few beds are limestone containing marine fossils, most of the beds are nonmarine shale and sandstone. The Strawn group has not been divided into formations on the outcrop in the Colorado River valley as it has been in the Brazos River valley to the NE.; nor can equivalent beds be traced, with the exception of the Capps limestone lentil of Plummer and Moore, from one valley to another. The Strawn is accordingly considered in this paper as one mappable unit.

The Strawn becomes thinner from central Brown County, where it is reported to be 1,100 ft. thick in wells, to 500 ft. in N.-central Coleman County; and from 1,235 ft. in northern Brown County to about 250 ft. in southwestern Brown County and southeastern Coleman County.

Rocks of the Canyon group are about 600 ft. thick in the Colorado River valley. They consist chiefly of thick beds of limestone that form the most prominent cuestas of the region, and of intervening beds of shale and sandstone that generally occupy the frontal slopes of the cuestas and the valley bottoms. The Canyon group has been divided into 4 formations; from bottom to top, the Graford, the Winchell, the Brad, and the Caddo Creek.

The Cisco group, about 400 ft. thick, consists chiefly of shale containing channel-fill deposits of chert conglomerate and sandstone, and thin beds of limestone. It has been divided into the Graham and Thrifty formations.

The Wichita group consists chiefly of formations composed of a shale unit underlying a prominent, but generally thin, limestone unit. Deeply cut channels filled with sandstone and conglomerate are present in the lower formations of the group, the Pueblo and Moran formations. Only the stratigraphy of the lower part of the Pueblo formation is discussed.--Auth.

2-2247. Tozer, E.T. SUMMARY ACCOUNT OF MESOZOIC AND TERTIARY STRATIGRAPHY, CANADIAN ARCTIC ARCHIPELAGO: Canada, Geol. Survey, Paper 60-5, 24 p., 4 maps, fold. chart, 2 secs., 1960, 49 refs.

Mesozoic and Tertiary rocks of the Canadian Archipelago occur mainly in the Queen Elizabeth Islands and are best developed in the Sverdrup basin where there is an essentially conformable Pennsylvanian to early Tertiary sequence. Marine and nonmarine formations alternate; closely similar facies occur at several levels, and the geographic position of the marine sand-shale facies boundary is commonly the same for deposits of different ages. Marine faunas of many ages have been identified. Triassic-Scythian, Arisian, Ladinian, Karnian, Norian, Jurassic-Sinemurian, Toarcian and lower Bajocian, Bathonian or Callovian, Callovian, Oxfordian, Oxfordian or lower Kimmeridgian, Portlandian, Cretaceous-Berriasian and Valanginian, Aptian(?) and Albian, Cenomanian or Turonian, Santonian or early Campanian. Nonmarine formations represent the following time intervals - Late Triassic and possibly early Jurassic, late Jurassic, Lower Cretaceous and mid-Cretaceous. Tertiary beds are entirely nonmarine (Eureka Sound formation). Conglomerates high in the Eureka Sound formation probably indicate onset of Tertiary earth movements that followed the long, quiet period of sedimentation within the Sverdrup basin. Except for the fluviatile and deltaic Beauport formation of the Arctic Coastal Plain, of possible Pleistocene age, there are no known postorogenic Tertiary deposits. Thickness of deposits within the basin are: Triassic 17,500 ft., Jurassic 1,500, Cretaceous 12,000, Tertiary 10,000. Probable sources of sediments are from N. and E. Much of the quartzose material may be redeposited Devonian sandstone.--P. Harker.

2-2248. Ilin, V.D., G.M. Belyakova, and O.I. Shmidt. SEDIMENTS OF THE DANIAN STAGE IN THE LOWER AMU-DAR'YA REGION: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 10-B, p. 890-891, 1958, [pub. 1960], 4 refs.

In a short note the presence of typical littoral desits at the top of the Cretaceous section of the S. al region is mentioned. Its fauna consists of a mbination of Upper Cretaceous and lower Tertiary ms with an echinoid, Echinanthus burlensis Ba- unus, characteristic for the Danian. This permits proximate tracing of the former shoreline of the rine Danian, which is absent to the N. of the Aral a.--C. Voûte.

2249. Pishvanova, L.S. PROBLEM OF THE RATIGRAPHY OF THE MIOCENE SEDIMENTS THE SOLOTVIN DEPRESSION OF THE TRANS- RPATHIAN DOWNWARP: Geologiya Nefti - Pe- leum Geology [in translation], v. 2, no. 12-A, 1011-1017, table, 1958, [pub. 1960], 11 refs.

A stratigraphic subdivision is proposed of the Tor- ian (middle Miocene) of the Transcarpathian down- rp, based upon foraminiferal assemblages found a deep research well. A close correlation is pos- ble with the sequence in the Cis-Caucasus. A typ- al marine fauna with Candorbulina universa (Orb.) licates the beginning of a broad transgression of lower Tortonian sea embracing both the western ritories of the U.S.S.R. as well as many regions western Europe. This fauna has also been re- rded from Roumania, Hungary, Czechoslovakia, d Poland. Other characteristic horizons, found in h Ciscarpathia and in Transcarpathia, include a t or gypsum-anhydrite suite, a radiolarian hori- n, and a Globigerina bulloides Orb. horizon. The undant planktonic Foraminifera high up in the Tor- ian suite confirms the presence of a later Tor- ian transgression, not only in Transcarpathia and Cis-Caucasus, but also in Roumania and Poland. C. Voûte.

2250. Higgins, Charles G. OHLSON RANCH RMATION, PLIOCENE, NORTHWESTERN SONO- COUNTY, CALIFORNIA: California, Univ., Pubs. ol. Sci., v. 36, no. 3, p. 199-231, 5 illus., 4 ps (1 in pocket), secs., 2 tables, 1960, 18 refs.

General region: northern California coast, about mi. NW. of San Francisco. Outcrop area: struc- al-topographic trough about 23 mi. long, 4 mi. de, parallel to and 2 mi. E. of the coast line. pe locality: Annapolis quadrangle, Ernest Ohlson nch, 5 1/2 mi. E. of Stewarts Point, N 1/2 sec. 3, 9 N., R. 13 W., M.D. Preservation: patchy, poor- exposed, 500-1,700 ft. above sea level on hill- s, unconformably overlying Franciscan forma- n. Thickness: 0 to 300 ft. Lithology: marine sand- ne, siltstone, and conglomerate, similar to erced formation," Pliocene, in the Sebastopol region, 14 mi. SE.; includes fluviatile(?) conglomerates. Age: middle (and upper?) Pliocene; disconformity of unknown magnitude occurs within the section. Deposition: mollusk-bored wave-cut terraces and stacks buried beneath the formation show that, like the "Merced" to the SE., it was essentially a shallow-water terrace deposit; sediments came from both NE. and SW., suggesting deposition in a NW.-trending embayment connected to the ocean through a sag in the coastal ridge 4 mi. N. of Stewarts Point; there is no evidence that this joined the Pliocene embayment in the Sebastopol region. Postdepositional deformation: slight; the shallow, synclinelike basin was accentuated and broken by renewed movement of pre-Pliocene normal, reverse, and strike-slip faults.--Auth.

2-2251. Peck, Joseph H., Jr. PALEONTOLOGY AND CORRELATION OF THE OHLSON RANCH FORMATION: California, Univ., Pubs. Geol. Sci., v. 36, no. 4, p. 233-241, pl., 2 tables, 1960, 9 refs.

The Ohlson Ranch fauna consists of 43 species including Anadara trilineata, Arca n. sp., Clinocardium meekianum, Patinopecten purisimaensis, Chlamys egregius, Schizothaerus parjaroanus, Schizopyga moraniana, Colus recurvus, Terebratalia arnoldi etchegoini, and Terebratulina unguicula. This assemblage is referred to the Pliocene, and is believed to be equivalent in age to the lowermost Merced formation of the San Francisco peninsula and the upper type Purisima formation. The fauna suggests that during the time of deposition sea-surface temperatures were somewhat warmer than at the present.--Auth.

2-2252. Hurley, Patrick M. HOW OLD IS THE EARTH?: 160 p., 8 pls., 27 figs. incl. diags., graphs, Garden City, New York, Anchor Books, Doubleday & Company, 1959, 4 refs.

The measurement of time by study of the continuous breakdown of radioactive elements has had great impact on science and philosophy. The radioactive breakdown of nuclei of atoms like U and Th releases energy which is transformed into heat and flows to the surface of the earth. Radioactivity has supplied most of the energy for the earth's great geologic events and it also measures the time at which these events have occurred. In developing this theme for the science student and the general reader, the following subjects are discussed: structure of the earth, radioactivity, radioactive earth, measurement of absolute geologic time, memorable dates in earth history, earth's beginnings.--A.C. Sangree.

5. PALEONTOLOGY

also: Stratigraphy 2-2245, 2-2248, 2-2249, 2-2251.

2253. Fischbuch, N.R. STROMATOPOROIDS THE KAYBOB REEF, ALBERTA: Alberta Soc. troleum Geologists, Jour., v. 8, no. 4, p. 113- , 138, 26 illus., 2 maps, chart, 2 logs, Apr. 1960, refs.

From 100 thin sections of core chips from the averhill Lake formation [Devonian] of the Kaybob ea, and also from the Slave Point(?) formation evonian] of the North Peace River area of Alberta, species of the genera Actinostroma, Stromatopora, chyodes, and Amphipora are figured and described. The above named genera are found also in the lower Cairn formation [Devonian] of the Rocky Mountains, the Waterways formation [Upper Devonian], and the Swan Hills member of the Beaverhill Lake formation in the nearby Swan Hills field. The correlation suggested by stromatoporoids agrees with a brachiopod correlation. Amphipora are not diagnostic.--Auth.

2-2254. Taylor, Dwight W. LATE CENOZOIC MOLLUSCAN FAUNAS FROM THE HIGH PLAINS: U.S. Geol. Survey, Prof. Paper 337, 94 p., 4 pls., 2 figs., 19 tables, 1960, 150 refs.

Mollusks are described from 9 late Cenozoic assemblages in the High Plains region: the late middle Pliocene Buis Ranch local fauna of northwestern Oklahoma; the late Pliocene Saw Rock Canyon, Rexroad, and Bender local faunas of southwestern Kansas; the late Pliocene Red Corral local fauna of the Panhandle of Texas; the early Pleistocene Dixon, Deer Park, and Sanders local faunas of southern Kansas; and the early Pleistocene Sand Draw local fauna of N.-central Nebraska. In nearly all assemblages associated mammals provide an independent age determination. The control provided by fossil mammals and stratigraphic succession permits evaluation of the mollusks for age determination and correlation. Vertebrates and mollusks are complementary, and never antagonistic, in giving age and ecologic information.

The late Pliocene and Pleistocene faunal sequence of southwestern Kansas and northwestern Oklahoma is especially significant for regional and intercontinental correlation because it is the most nearly complete sequence known from such a small area. Collecting the great number of specimens and species which represent these faunas has been possible by washing large quantities of fossiliferous matrix through screens. Ecologic interpretation of the mollusks is combined with other information from the vertebrates and inferences from the depositional sequence to summarize the late Pliocene and Pleistocene climatic and faunal sequence of southwestern Kansas.

Fossils from 3 horizons in the Rexroad formation indicate a relatively long interval in which the climate was warm-temperate, equable, and relatively moist. Above these assemblages the depositional and erosional sequence, and several faunas, indicate 4 periods of erosion and deposition of coarse clastic sediments in cool climates separated by 3 periods of deposition of finer materials during warmer climates. The alternate warm and cool climates are correlated with the Mississippi Valley interglacial and glacial ages. The Ballard formation, which is separated from the Rexroad formation by an erosional unconformity and contains the earliest evidence of marked climatic cooling, is correlated with the earliest Pleistocene sediments of the area in central Italy selected by the 18th International Geological Congress as definitive for the Pliocene-Pleistocene boundary.

The successive phases in the history of North American land mammals which have been called the Blancan, Irvingtonian, and Rancholabrean ages can be correlated with the Pliocene and Pleistocene sequence of southwestern Kansas, and thus indirectly with the glacial-interglacial intervals of the Mississippi Valley. The Blancan is late Pliocene and early Pleistocene. The Blancan-Irvingtonian boundary is about in the middle of the Kansan age, and the Irvingtonian-Rancholabrean boundary about in the middle of the Illinoian age.--Auth.

2-2255. Palmer, Allison R. TRILOBITES OF THE UPPER CAMBRIAN DUNDERBERG SHALE, EUREKA DISTRICT, NEVADA: U.S. Geol. Survey, Prof. Paper 334-C, p. 53-109, 8 pls., 18 figs. incl. maps, diags., 1960, 82 refs.

The Dunderberg shale in the Eureka district is the northwesternmost expression of a relatively thin nonresistant unit (100-300 ft. thick) of interbedded shale and fossiliferous limestone of Late Cambrian age lying between generally less fossiliferous and more resistant carbonate units in southeastern Nevada and adjacent parts of Utah and California. Five local lithic units, designated by letter and beginning at the base with a shale unit (A), are recognized within the Dunderberg shale. Overlying units alternate in dominance between limestone and shale. All but the upper unit (E) contain thin fossiliferous limestones bearing generally distinctive trilobite assemblages. Ranges of many common species are sufficiently restricted so that isolated collections from structurally disrupted areas within the Eureka district can be placed within 20 to 40 ft. of their original stratigraphic position within the upper or lower parts of the Dunderberg shale. The fauna of units A-C belongs to the upper half of the Dunderbergia zone of late Dresbach age. The fauna of unit D correlates with the basal part of the Elvinia zone of early Franconia age. The presence of Homagnostus obesus (Belt) and Olenus? wilsoni Henningsmoen in units A and B indicates a correlation of these beds with the Olenus and H. obesus zone in the early Late Cambrian section of the Scandinavian region.

Fifty-three species representing 32 genera are described. The following new taxa are named: subfamily Aphelaspidinae (of the family Pterocephaliidae); genera Elburgia, Elviniella, Prehousia, Parahousia, Cernuolimbus, Sigmocheilus, Taenora, Minupeltis, Morosa, Anechocephalus; and species, Dunderbergia bigranulosa, D. polybothra, Elviniella laevis, Prehousia semicircularis, P. alata, Parahousia constricta, Housia ovata, Cernuolimbus semigranulosus, C. orygmatos, C. depressus, Pterocephalia concava, P. elongata, Litocephalus verruculapeza, L. granulomarginatus, Taenora expansa, Sigmocheilus serratus, Minupeltis conservator, Morosa longispina, Bynumiella? acuminata, Anechocephalus trigranulatus, Pseudosaratogia leptogranulata, and P. abnormis. Evidence is shown that primary species characteristics are to be found in the external ornament of the exoskeleton. Genera are composed of species sharing nearly common shape but differing consistently in characteristics such as external ornament. Emphasis in family groupings is placed on structure of the glabella, frontal area, and pleural parts of the pygidium. Application and elaboration of the principles for grouping trilobites into genera and families are illustrated particularly with regard to the families Elviniidae, Housiidae, and Pterocephaliidae.--Auth.

2-2256. McKenna, Malcolm C. FOSSIL MAMMALIA FROM THE EARLY WASATCHIAN FOUR MILE FAUNA, EOCENE OF NORTHWEST COLORADO: California, Univ., Pubs. Geol. Sci., v. 37, no. 1, 130 p., 64 figs. incl. map, 10 tables, 1960, 120 refs.

By an underwater screening process a large quantity of remains of fossil vertebrates has been recovered from the apparently almost barren sediments of the Hiawatha member of the Wasatch formation in northwestern Colorado. At least 78 vertebrate species are represented, of which 58 are mammals. These remains are of earliest Wasatchian age and demonstrate that in at least one area deposition of the Wasatch formation began as early as and possibly earlier than the beginning of Eocene time.

The insectivore family Nyctitheriidae is abandoned. The family Amphilemuridae is recognized for the first time as present in North America. A possible Wasatchian member of the erinaceoid family Metacodontidae is described. A tiny new genus of Omomyinae is proposed. Simpson's family Phenacolemuridae is abandoned in favor of the available antecedent taxon Paromomyinae. The Microsyopidae are separated from the Mixodectidae, and both families are removed from the Insectivora. Simpson's systematic reatment of Ectocion, a well-known illustration of ie chronocline concept, is revised. The Aphelis- idae are removed from the Insectivora and clas- ified as a subfamily of hyopsodont Condylarthra.-- uth.

-2257. Douglass, Raymond C. THE FORAMINI- ERAL GENUS ORBITOLINA IN NORTH AMERICA: .S. Geol. Survey, Prof. Paper 333, 52 p., 17 pls. ncl. 3 secs. (in pocket), 32 figs. incl. maps, diags., tables, 1960, 132 refs.

The foraminiferal genus Orbitolina has been use- ul as an index fossil in the Cretaceous rocks of the ircumglobal equatorial belt for nearly a century. n Europe and the Near and Middle East enough work as been done on the species to allow their use for pproximate correlations within the Cretaceous sedi- entary rocks. The study of American specimens f Orbitolina had been almost neglected although they ere used in a rather cursory fashion for markers f the Lower Cretaceous Trinity strata. Three pecies had been described and assigned to Orbitolina n the United States, but the validity of each of the pecies had been questioned. A study of the genus rbitolina, its type species, its morphology, and the tratigraphic and geographic distribution in North merica are presented in this report.

Stratigraphic sections were measured throughout he area of Lower Cretaceous outcrop in Texas, New lexico, and Arizona, and samples of Orbitolina were aken from these measured sections. Several thou- and thin sections were prepared from which 8 species f Orbitolina, 7 of them new, were recognized. Or- itolina texana (Roemer) was found to be confined to he lower part of the Glen Rose limestone and its quivalents. Orbitolina minuta n. sp. is essentially onfined to the upper part of the Glen Rose limestone nd its equivalents. Four of the species are known nly from the Arizona and New Mexico region. The pecies of Orbitolina are useful stratigraphically, ut all their characters - internal as well as exter- al - must be considered. The use of thin sections or the study of Orbitolina is essential.

One of the first things that had to be determined as the correct concept of the genus Orbitolina. he type species had not been determined by earlier uthors, although 4 species had been suggested at arious times. With careful study of the early liter- ture, it became apparent that the type species is rbulites lenticulata Lamarck, 1816 = Madreporites enticularis Blumenbach, 1805 by monotypy.

The type species had never been studied using odern techniques. This paper presents the first escription and illustrations of the type species ased on internal as well as external characters.

The American forms of Orbitolina had been refer- ed to the species Orbitolina concava (Lamarck) by ilvestri and others. The necessity of understanding . concava was apparent. Many misconceptions bout O. concava had been developed and propagated ntil the modern concept no longer included the orig- nal material on which the species was based.

Topotype material of Orbulites concava Lamarck, 816, was restudied. For the first time both the nternal and the external characters are described nd illustrated. Orbitolina concava (Lamarck) is ot conspecific with any of the North American forms.

A thorough knowledge of the morphology of Or- itolina is essential to the interpretation of the fea- ures as seen in thin section. Carefully oriented ections were prepared and models built up illustrat- ng the morphology. A new technique was adapted or multiple sectioning of specimens of Orbitolina. Using this technique, several oriented sections can be prepared from one specimen, enabling the correlation of features seen in axial, basal, and tangential sections. This technique should prove useful in the study of similar small objects, and therefore is described and illustrated.

The early chambers of microspheric and megalospheric specimens were not well known. A technique for their study was developed and is described. The morphology of the early chambers of both generations is described and illustrated. The nature of the nepionic and neanic chambers of the microspheric generation is described and documented for the first time. The previous supposition of an early trochoid spire in microspheric specimens is rejected in favor of a flaring planispiral coil. This discovery must be considered in a study of the phylogeny.

Charts are presented showing the stratigraphic and geographic distribution of Orbitolina in the Texas, New Mexico, and Arizona sections. These charts should prove useful in the study of both surficial and subsurface samples of Trinity equivalents from Florida to Arizona.--Auth.

2-2258. Boucot, Arthur J., and Robert H. Arndt. FOSSILS OF THE LITTLETON FORMATION (LOWER DEVONIAN) OF NEW HAMPSHIRE: U.S. Geol. Survey, Prof. Paper 334-B, p. 41-51, 3 illus., 2 maps, table, 1960, 15 refs.

Reexamination and study of fossils collected from 3 localities in New Hampshire show the presence of the brachiopods Amphigenia and Eodevonaria cf. E. arcuata at 2 of the localities. The evidence suggests a correlation of the containing strata with the Camden chert (Lower Devonian) of Tennessee. All the fossils are from slightly metamorphosed (chlorite zone) strata of the Littleton formation in northern New Hampshire. Fossils from highly metamorphosed (sillimanite zone) rocks correlated with the Littleton formation are determined to be of post-Early Ordovician age. Several thousand feet of unfossiliferous post-Silurian rocks, below the fossiliferous strata (Littleton formation) in the Littleton quadrangle, are present in part of the adjoining Whitefield quadrangle. The absence of these strata in part of the Whitefield quadrangle may be due to nondeposition or to erosion prior to deposition of strata of Camden age.--Auth.

2-2259. Conley, James F. IMPRESSIONS RESEMBLING WORM BURROWS IN ROCK OF THE CAROLINA VOLCANIC-SEDIMENTARY GROUP, STANLY COUNTY, NORTH CAROLINA: Southeastern Geology, v. 1, no. 4, p. 133-137, illus., map, Apr. 1960, 4 refs.

Impressions which resemble worm burrows have been discovered in southern Stanly County, North Carolina. The rock underlying this area is a member of the Carolina volcanic-sedimentary group, popularly known as the Carolina slate belt, which has always been considered unfossiliferous. The unit in which the markings occur is an unweathered, slightly metamorphosed, water laid, volcanic tuff. The markings have not been positively identified as organic, however, they do not resemble any reported mineral form or sedimentary feature. In addition the markings are not limited to bedding planes, but weave back and forth as well as up and down through the rock, indicating that they were produced by a mobile form, such as a burrowing organism.

Although not positively identified these markings are quite similar to worm burrows and might be the first fossils discovered in the Carolina volcanic-sedimentary group.--Auth.

6. GEOPHYSICS

See also: Geologic Maps 2-2186 through 2-2197, 2-2207; Structural Geology 2-2232, 2-2240; Mineral Deposits 2-2416; Fuels 2-2428, 2-2441; Engineering Geology 2-2452.

2-2260. Keller, George V. PULSE-TRANSIENT BEHAVIOR OF BRINE-SATURATED SANDSTONES: U.S. Geol. Survey, Bull. 1083-D, p. 111-129, 7 diags., 6 graphs, 4 tables, 1960, 8 refs.

The electrical-transient response of 24 water-saturated sandstone cores was studied as a function of the salinity of the saturating solution. The transient response, or polarization expressed as the ratio of the integrated transient to the steady-state voltage applied to the samples, was found to decrease slightly with increasing salinity of the saturating solution. A comparison of electrical-transient data with measurements of porosity, permeability, and cation-exchange capacity of the samples suggests that the mechanism of electric polarization is primarily an anion-trap phenomenon rather than an electro-osmotic effect.--Auth.

2-2261. SEISMOLOGICAL NOTES: Seismol. Soc. America, Bull., v. 50, no. 1, p. 153-161, illus., map, 2 diags., 4 tables, Jan. 1960.

Tabulates data pertaining to 36 nuclear explosions in Nevada (Operation Hardtack) during 1958. Approximately 70 natural earthquakes throughout the world were also briefly reported including an eyewitness account in the epicentral region of the 1959 western Nevada quake at the Black Mountain microwave site. Also included are the particulars for the larger aftershocks of the Hebgen Lake, Montana earthquake. Dates covered are from June 23, 1959 to Oct. 15, 1959. --E. Aleshin.

2-2262. Benioff, Hugo. LONG-PERIOD SEISMOGRAPHS: Seismol. Soc. America, Bull., v. 50, no. 1, p. 1-13, 17 figs., Jan. 1960, 7 refs.

Descriptions and theories of a number of different seismographs developed particularly for recording of very long-period seismic waves are presented. These include 1) electromagnetic strain seismograph with galvanometer of 8 min. period and photographic recording, 2) displacement transducer strain seismometer with resistance-capacitance network and short-period galvanometer photographic recorder or with ink-writing recorder, 3) electromagnetic pendulum seismometer with RC network having transfer characteristic of a long-period galvanometer recorder or a heated stylus visible writer, 4) electromagnetic pendulum with period increased tenfold or more using shunt capacitance, and 5) electromagnetic pendulum with condenser-lengthened period and triple RC integrating network recording with either heated stylus visible writer, ink writer, or short-period galvanometer photographic recorder.--Auth.

2-2263. QUAKE PREDICTION FORESEEN: Sci. News Letter, v. 77, no. 26, p. 406, June 25, 1960.

"The U.S. Coast & Geodetic Survey plans to furnish standard seismological equipment worth $500,000 to 20 of their 25 seismological stations in the United States and 30 stations in foreign countries cooperating with the U.S. on earthquake information." The aim of the program will be to locate the epicenters of more earthquakes and obtain more data so as to be able to predict when and where earthquakes will occur.

It is estimated that, with better equipment, the Survey will be able to locate 4,000 to 5,000 earthquakes a year compared to the 1,500 it can pinpoint today.--L.M. Dane.

2-2264. Droste, Sophia, and Roman Teisseyre. THE THEORY OF THE DISLOCATION PROCESSES AND ITS APPLICATION TO THE PACIFIC REGION: Seismol. Soc. America, Bull., v. 50, no. 1, p. 57-70, 12 figs., Jan. 1960, 16 refs.

This paper deals with the mechanism of earthquakes according to dislocation theory. An attempt is made to explain the dislocation processes in the region of troughs and ridges. A preliminary comparison of the proposed dislocation mechanism with the Pacific region data is discussed.

For the sake of simplification the seismic processes are considered only in a plane which plays the part both of the hypocentral and the dislocation plane. Two factors are of special interest - stresses and inhomogeneities. In the stress field we can describe the inhomogeneities by loop-type dislocations. The stress field influences their extent and movement by which the greater dislocation elements are formed. These elements may in approximation be regarded as pairs of 2 unlike linear dislocations. We may therefore assume the existence of pair creation areas. By the parting of the dislocation lines of a pair the dislocation area enclosed by them is increased. There may occur the junction of 2 or more extending dislocation areas. This junction is accompanied by release of the energy accumulated around the dislocation limiting lines, which are thus annihilated. Similarly, when the dislocation reaches the earth's surface a discharge of its dislocation energy occurs.--Auth.

2-2265. Knopoff, Leon, and Freeman Gilbert. FIRST MOTIONS FROM SEISMIC SOURCES: Seismol. Soc. America, Bull., v. 50, no. 1, p. 117-134, 9 figs., Jan. 1960, 8 refs.

An application of dynamic dislocation theory gives the elastodynamic radiation resulting from the sudden occurrence of an earthquake due to faulting. The fault plane is visualized as a geometrical discontinuity across which there exists a sudden discontinuity in either one component of the strain tensor or one component of the displacement vector. It is shown that there are 8 independent models, if unilateral faulting is assumed; and an argument is presented to demonstrate the likelihood that unilateral faulting does not exist in nature. For bilateral faulting the 8 independent models are reduced in number to 5. Of these 5, 2 are more likely to occur in nature than the others. One of these, the displacement dislocation model, has a first-motion radiation pattern formally identical with that of a double couple in an unfaulted medium. The second, the shear-strain dislocation model, has a first-motion radiation pattern formally identical with that of an isolated force in an unfaulted medium. The latter type of mechanism may occur in deep-focus earthquakes. Another type of radiation, corresponding to the single couple in an unfaulted medium, results from the sudden release of shear strain in a laminar region.--Auth.

2-2266. Tocher, Don. THE ALASKA EARTHQUAKE OF JULY 10, 1958: MOVEMENT ON THE FAIRWEATHER FAULT AND FIELD INVESTIGATION OF SOUTHERN EPICENTRAL REGION: Seismol. Soc. America, Bull., v. 50, no. 2, p. 267-292, 21 illus., diag., 2 tables, Apr. 1960, 15 refs.

The Fairweather fault is recognizable as a geoogic and geomorphic feature from Palma Bay on the E. at least as far NW. as Nunatak Fiord E. of akutat Bay, a distance of 200 km. along the surface race. The earthquake of July 10, 1958, was caused y movement on much or all of the segment of the ault: a 10-ft. or larger right-lateral offset occurred t Palma Bay where the surface trace trends southastward under the ocean, and fresh scarps were ormed on the S. shore of Nunatak Fiord. A dislacement in which the SW. side moved relatively W. 21 1/2 ft. and up 3 1/2 ft. was measured at one oint on the fault just E. of the N. end of Crillon ake. Continuity of breakage between Palma Bay and unatak Fiord cannot be demonstrated positively because ice and water conceal the ground surface in he fault zone along about 80% of that distance.

Extensive minor faulting in bedrock E. of the enter of Crillon Lake was observed on flat areas on oth sides of the Fairweather fault. These systems f minor faults were similar in general appearance o those formed on the Nunatak at Nunatak Fiord both n this earthquake and in the Yakutat Bay earthquakes f 1899.

A wide variety of geological effects other than aulting was observed throughout a broad area along he Pacific coast from Cape Spencer to Mount St. lias. Among these were earth and rock avalanches, now and ice avalances, earth slumps, earth lurches, nd sandblows from craterlets and fissures.--Auth.

-2267. Davis, T. Neil, and Norman K. Sanders. ALASKA EARTHQUAKE OF JULY 10, 1958: INTENSITY DISTRIBUTION AND FIELD INVESTIGATION OF NORTHERN EPICENTRAL REGION: Seismol. oc. America, Bull., v. 50, no. 2, p. 221-252, 23 llus., 5 maps, diag., Apr. 1960, 16 refs.

The July 10, 1958 earthquake centered near Lituya ay, Alaska, produced moderate property damage at akutat, 100 mi. to the NE., and was readily felt ithin 400 mi. of the epicenter. Five persons died uring the eathquake: 2 in Lituya Bay, where a catalysmic wave sank 2 fishing vessels; 3 others near akutat, when a beach on which they were standing ell 100 ft. beneath the sea. The earthquake caused arge slides in the mountain areas and produced reat numbers of sandblows and fissures on the low oastal plain SE. of Yakutat.--Auth.

2-2268. Miller, Don J. THE ALASKA EARTHQUAKE OF JULY 10, 1958: GIANT WAVE IN LITUYA BAY: Seismol. Soc. America, Bull., v. 50, no. 2, p. 253-266, 5 illus., map, Apr. 1960, 16 refs.

Lituya Bay, a T-shaped tidal inlet on the NE. shore f the Gulf of Alaska, heads in the trench along the airweather fault. Displacement along this fault at he time of the earthquake of July 9, 1958 (local time), riggered a rockslide into deep water in Gilbert Inlet, ne of the 2 arms at the head of Lituya Bay. The ockslide, with a volume of 40 million cu. yds., aused water to surge to an altitude of 1,740 ft. on a pur opposite the point of impact, and generated a ravity wave that swept 7 mi. to the mouth of the bay t a speed probably between 97 to 130 m.p.h. The urge and wave of water destroyed the forest on the hores over an area of 4 sq. mi., sank 2 of 3 fishing oats in the outer part of the bay, and took 2 lives. --Auth.

2-2269. Tocher, Don. THE ALASKA EARTHQUAKE OF JULY 10, 1958: Seismol. Soc. America, Bull., v. 50, no. 2, p. 217-220, map, 2 tables, Apr. 1960.

This is a general introduction to the 4 following articles by several authors who cooperated in making studies of various aspects of this major shock.--Auth.

2-2270. Stauder, William V. THE ALASKA EARTHQUAKE OF JULY 10, 1958: SEISMIC STUDIES: Seismol. Soc. America, Bull., v. 50, no. 2, p. 293-322, 13 figs. incl. map, 2 tables, Apr. 1960, 16 refs.

The instrumental epicenter of the Alaska earthquake of July 10, 1958, has been located on the hanging-wall side of the Fairweather fault near the surface expression of the fault and at the SE. end of the greatly disturbed area.

The fault-plane solution from P waves gives a fault plane which differs by 15° from the strike of the observed surface faulting. The theoretical relative amplitudes computed from the fault-plane solution are interpreted as partly explaining the residuals of P arrivals and inconsistent directions of the first motion of P.

The directions of polarization of the S waves are found to conform to the pattern expected for a single couple as the point-source model of the focal mechanism. A method is suggested for using S waves to check fault-plane solutions from P and to select the fault plane from the 2 nodal planes of P.

Observations of S at near stations do not correspond to the pattern expected for a couple. Large transverse motion is observed along the azimuth of the fault. In the western United States, at stations along the same azimuth, the SH motion changes progressively to SV with distance. Large SV components at distances of 25° to 27° indicate that the critical angle for SV may be reached at these distances and that even long S waves are refracted by structure within the crust.--Auth.

2-2271. Richter, C. F. EARTHQUAKES IN OWENS VALLEY, CALIFORNIA, JANUARY-FEBRUARY, 1959: Seismol. Soc. America, Bull., v. 50, no. 2, p. 187-196, map, 10 tables, Apr. 1960, ref.

In Jan. 1959, 2 series of small earthquakes originated in southern Owens Valley. The first and largest of these, of magnitude 4.7, originated on Jan. 5, 12:36:02.9 GCT, near 36°09'N., 118°03'W., near Haiwee. This and other shocks of the series were well recorded by standard and strong-motion instruments at Haiwee, showing the characteristic false S - P of about one second. The timing is good, and demonstrates that no change of supposed epicenter, depth, or velocities can reasonably account for the second phase as S. Other shocks were located at 36°07'N., 118°03'W., which probably represents the terminus of faulting in the first shocks.

A shock of magnitude 3.2 occurred on Jan. 7, at 00:20:40.2 GCT near 35°46'N., 117°35'W., near China Lake. This was followed by numerous others from the same source, mostly showing a false S, and recorded by the Benioff instrument at China Lake down to very small magnitudes. However, shocks of this group of magnitude 0.7-0.8 were more numerous than those of magnitudes 0.0-0.6.

Initial compressions and dilatations in both groups of shocks were consistent, especially at the nearer stations, but lead to no simple fault-plane solutions. --Auth.

2-2272. Richter, C. F., and John K. Gardner. THE WALNUT, CALIFORNIA, EARTHQUAKES OF

JULY-AUGUST, 1959: Seismol. Soc. America, Bull., v. 50, no. 2, p. 181-185, 4 tables, Apr. 1960, 2 refs.

A swarm of minor earthquakes began on July 29, 1959, near 34°00'N., 117°48'W. Records at Pasadena show P and S waves reflected from the Moho. A portable instrument recorded some of these at a point about 6 km. from the epicenter. The characteristic false S - P of about one second at short distances was recorded.--Auth.

2-2273. Nuttli, Otto W. A NOTE CONCERNING THE SENSE OF THE P MOTION FOR THE MONTANA EARTHQUAKE OF AUGUST 18, 1959: Seismol. Soc. America, Bull., v. 50, no. 2, p. 211-215, 4 figs., Apr. 1960.

The short- and long-period seismograms at both St. Louis and Florissant appear to indicate an opposite sense of the first P motion for the Montana earthquake of Aug. 18, 1959. The P motions are impulsive and seem to arrive simultaneously on both the short- and long-period seismograms.

In order to avoid any doubt about the relation between trace and ground displacements, seismograms of the earthquake of Aug. 26, 1959, are reproduced. The first P motion is impulsive, and shows the same sense on both the short- and long-period seismograms.--Auth.

2-2274. Gutenberg, Beno. WAVES REFLECTED AT THE "SURFACE" OF THE EARTH: P'P'P'P': Seismol. Soc. America, Bull., v. 50, no. 1, p. 71-79, 8 figs., Jan. 1960, 13 refs.

Phases of the 600 km. deep earthquake of Apr. 16, 1957, which have not been reflected at the earth's surface show very sharp beginnings arriving within the limits of error of a few seconds at the calculated times. However, phases which have been reflected at the surface, for example PP, pP', pPP, have more or less emergent beginnings which arrive between a few seconds and as much as 30 sec. too early. These emergent beginnings are followed by an impulse which arrives at nearly the calculated time. In agreement with earlier findings, it is concluded that the emergent beginnings of such waves are caused by waves which have been reflected at the Mohorovičić discontinuity or other discontinuities below the surface. Observations of such early emergent arrivals also include waves of the types P'P', PKSP', P'P'P' which have passed twice or more through the mantle and the core.

P'P'P'P' has been observed for the first time. The travel times of P'P'P'P' and the coefficient of absorption calculated from P'P'P'P' and P' agree within the limits of error with the expected values; however, these limits of error are so large that the results cannot be used to improve earlier findings. The periods of P'P'P'P' which has traveled about 50,000 km. through mantle and core do not show a marked change from those observed in P waves which have traveled only a few thousand kilometers through the mantle.--Auth.

2-2275. Dorman, James, Maurice Ewing, and Jack E. Oliver. STUDY OF SHEAR-VELOCITY DISTRIBUTION IN THE UPPER MANTLE BY MANTLE RAYLEIGH WAVES: Seismol. Soc. America, Bull., v. 50, no. 1, p. 87-115, 6 figs., 11 tables, Jan. 1960, 24 refs.

Comparison of Rayleigh-wave dispersion computations on 11 models of shear-velocity structure of the continental and oceanic crust-mantle systems permits a detailed explanation of observed mantle Rayleigh-wave dispersion for periods less than 250 sec. Velocity distributions for the continental crust-mantle obtained by Gutenberg and by Lehmann from body-wave data, both of which include a region of low velocity in the upper mantle, are consistent with the dispersion data. Furthermore, it is shown that a structure which agrees with results from travel times of body waves from explosions and from distant earthquakes and with Rayleigh-wave dispersion must necessarily contain a low-velocity region of this type.

Shear-wave data for oceanic areas are meager, but from Rayleigh-wave dispersion there is firm evidence that the shear velocity immediately below the M discontinuity of deep ocean basins is about 4.6 to 4.7 km./sec., about the same as under the continental M discontinuity. It is also clear that the velocity distribution below the depth of the continental M discontinuity cannot be the same under continents and oceans. Instead, an oceanic model obtained by successive approximation to oceanic Rayleigh-wave dispersion data shows that the region of low shear velocity extends to much shallower depths under the oceans, thus being a much more prominent feature under oceans than under continents. This is similar to results obtained by Landisman et al. using oceanic Love-wave dispersion, and provides a more detailed knowledge of the structure.

Relatively rapid downward increase of shear velocity between depths of about 400 to 500 km. is the chief cause of the observed minimum group velocity at about 225 sec. period. Curvature of the earth is probably the cause of systematic differences beyond periods of 200 to 250 sec. between observed group velocities and group velocities computed according to the flat-earth hypothesis.--Auth.

2-2276. Oliver, Jack E., and Maurice Major. LEAKING MODES AND THE PL PHASE: Seismol. Soc. America, Bull., v. 50, no. 2, p. 165-180, diag., 5 seismograms, table, Apr. 1960, refs.

The PL phase is a normally dispersed train of waves of periods greater than about 10 sec. beginning at or near the time of the initial P wave and sometimes continuing at least to the time of the beginning of the Rayleigh-wave train. With adequate instrumentation the PL phase is commonly observed at distances less than about 25° from shallow shocks. In general, surface particle motion is elliptical and progressive, and amplitudes are not greater than about 1/4 those of Rayleigh waves of the same period. Comparison of PL- and Rayleigh-wave dispersion shows that both waves propagate in roughly the same near-surface wave guide. Whereas Rayleigh waves correspond to normal- (nonleaking-) mode propagation, PL waves appear to correspond to leaking-mode propagation within this wave guide.--Auth.

2-2277. Herrin, Eugene T., and Paul D. Minton. THE VELOCITY OF Lg IN THE SOUTHWESTERN UNITED STATES AND MEXICO: Seismol. Soc. America, Bull., v. 50, no. 1, p. 35-44, 3 figs. incl. map, 3 tables, Jan. 1960, 9 refs.

The group velocities of 91 Lg arrivals at the Dallas Observatory in 1954, 1955, 1956, and 1957 have a mean of 3.468 ± 0.010 km./sec. A t-test shows that Lg waves traveling from Baja California to Dallas have a velocity significantly larger at the 0.999 probability level than those traveling from California to llas. Four Lg arrivals which traveled from Mex- o to Dallas across the outer continental shelf of the lf of Mexico have a mean velocity of 3.22 ± 0.03 ı./sec. A table for estimating epicentral distances om P and Lg arrival times is included.--Auth.

2278. Herrin, Eugene T., and Jean Richmond. N THE PROPAGATION OF THE Lg PHASE: Seis- ol. Soc. America, Bull., v. 50, no. 2, p. 197-210, igs., 14 tables, Apr. 1960, 13 refs.

Empirical determinations of the mean surface locity of Lg indicate a range from 3.47 to 3.54 km./ c., with one set of velocities off the E. coast of exico as low as 3.20 km./sec. Computations based ray theory show that Lg with these velocities may shear waves guided in the upper crust by an alter- tion of refractions and surface reflections. The ower velocities would result from shear waves aveling almost entirely in the sedimentary layer. larization of Lg is related to the angle at which the ided shear waves are incident at the surface.

Calculations show that Lg would travel in a con- ental crust covered by a considerable thickness of ater, thus supporting the hypothesis that the absence Lg indicates that an oceanic crust underlies such dies of water as the Gulf of Mexico. All computa- ons were run on the Univac 1103 at Southern Meth- ist University.--Auth.

2279. Press, Frank, and Hitoshi Takeuchi. OTE ON THE VARIATIONAL AND HOMOGENEOUS AYER APPROXIMATIONS FOR THE COMPUTATION F RAYLEIGH-WAVE DISPERSION: Seismol. Soc. merica, Bull., v. 50, no. 1, p. 81-85, diag., 4 bles, Jan. 1960, 4 refs.

An earlier study of upper mantle structure using variational method is repeated using the homogene- s layer approximation programmed for an electron- digital computer to obtain dispersion curves. The spersion curves computed by the 2 methods differ gnificantly but systematically so as to yield the me conclusion about the presence of the Gutenberg w-velocity zone in the upper mantle.--Auth.

2280. Ben-Menahem, Ari. DIFFRACTION OF LASTIC WAVES FROM A SURFACE SOURCE IN HETEROGENEOUS MEDIUM: Seismol. Soc. Amer- a, Bull., v. 50, no. 1, p. 15-33, 3 figs., table, n. 1960, 11 refs.

A theory is developed for wave propagation of a ven frequency emerging from a seismic surface urce in a medium in which the velocity is a con- nuous function of one coordinate only. It is as- med that the relative change of the elastic para- eters is very small over a wave length. The wave uations are then solved in cylindrical coordinates der suitable boundary conditions and integral re- esentations are obtained for the displacements, hich are generally valid. These integrals are then aluated for a special case with an almost linear ve- city gradient and the surface displacements are ob- ined for long ranges. It is found that the amplitude the body waves (both P and S) inside the shadow one decays exponentially with the distance from the urce at a rate proportional to 1/3 power of the equency and 2/3 power of the velocity gradient.-- ith.

-2281. Davids, Norman, ed. INTERNATIONAL YMPOSIUM ON STRESS WAVE PROPAGATION IN MATERIALS: 337 p., illus., charts, diags., graphs, tables, New York, Interscience Publishers, Inc., 1960, approx. 250 refs.

Stress wave propagation studies contribute directly to the phenomenological understanding of several scientific fields in which dynamic forces are involved, particularly those of an impact nature or arising from high rates of loading. Common experimental or theoretical techniques in related fields, similarity of problem solutions exchangeable between scientific and engineering areas, are conducive to accelerated progress. In recognition of these common scientific interests, the Office of Ordnance Research, U.S. Army, sponsored this symposium with the cooperation of the Pennsylvania State University on June 30, July 1 and 2, 1959. Well over 200 engineers and scientists personally active in the fields having a parallel interest in stress wave studies attended. This volume contains all the presented symposium papers with their respective discussions. The contributors were selected to obtain a representative cross-section of current progress in the various subjects of earth-layer propagation, visco-elastic materials, metallurgical effects, scabbing, rock-breakage, and armor penetration on a world-wide basis.--From pref.

Contents:

Thiruvenkatachar, V.R. Recent Research in Stress Waves in India, p. 1-14.

Curtis, C.W. Propagation of an Elastic Strain Pulse in a Semi-Infinite Bar, p. 15-43.

Pekeris, C.L. Propagation of Seismic Pulses in Layered Liquids and Solids, p. 45-57.

Kolsky, H. Viscoelastic Waves, p. 59-90.

Frocht, M.M. Studies in Dynamic Photoelasticity with Special Emphasis on the Stress-Optic Law, p. 91-118.

Kumar, Sudhir. Edge Waves in Plates, p. 119-131.

Eichelberger, R.J. Effects of Very Intense Stress Waves in Solids, p. 133-167.

Kymer, James R. Experimental Studies in Armor Penetration, p. 169-181.

Hillier, K.W. A Review of the Progress in the Measurement of Dynamic Elastic Properties, p. 183-198.

Lee, E.H. The Theory of Wave Propagation in Anelastic Materials, p. 199-228.

Broberg, K.B. Some Aspects of the Mechanism of Scabbing, p. 229-246.

Rinehart, John S. The Role of Stress Waves in the Comminution of Brittle, Rocklike Materials, p. 247-269.

Davids, Norman. Some Problems of Transient Analysis of Waves in Plates, p. 271-288.

Schardin, H. Cinematography of Stress Waves, p. 289-302.

Satô, Yasuo. Analysis of Dispersed Surface Waves, p. 303-327.

2-2282. Pomeroy, Paul W., and George H. Sutton. THE USE OF GALVANOMETERS AS BAND-REJECTION FILTERS IN ELECTROMAGNETIC SEISMOGRAPHS: Seismol. Soc. America, Bull., v. 50, no. 1, p. 135-151, 8 figs., Jan. 1960, 6 refs.

The large-amplitude intermediate-period, 4-9 sec., microseisms are effectively removed from high-magnification long-period seismograms with maximum magnification near 50 sec. period. This has been accomplished by the use of a galvanometer of natural period in the microseism range as a band-rejection filter. Addition of the filter galvanometer greatly increases the usefulness of these instruments for studies of long-period microseisms and for clear detection and resolution of the long-period components of both body and surface waves from small shocks at very great distances. Magnification equations and theoretical magnification curves show that extremely high sensitivities for desired periods and low sensitivities for undesired periods can be obtained by combining one or more filter galvanometers in seismograph systems, varying the damping constants and natural periods of the components, and varying the coupling between the components. Also, by proper choice of instrument parameters, undesired periods can be rejected without appreciable modification of the seismograph magnification for periods outside the rejection band.--Auth.

2-2283. PACIFIC BASIN HEAT FLOW: Naval Research Rev., Feb. 1960, p. 23.

Heat flow through the East Pacific rise is about 8 times the earth-wide average. Highest values are found in the center of the rise. With very low values on either side of the rise, the effect is believed to be due to a giant convection cell in the mantle.--R.F. McAllister.

2-2284. Elansky, L.N.O. REGULARITIES IN THE CHANGES OF PHYSICAL PARAMETERS OF ROCKS IN THE KUYBYSHEV TRANS-VOLGA REGION: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 10-B, p. 892-898, 4 maps, table, 1958, [pub. 1960], 10 refs.

Maps showing regional variations in density characteristics and in electrical conductivity of the sedimentary sequence from the Devonian upwards are briefly commented upon. Two density boundaries occur above the crystalline basement. The individual lithologic units and the sedimentary section as a whole show an increase in density towards the SE., attributed to a general subsidence of the basement of the Russian platform, the increase in amount of carbonate deposits, and for the deepest units also to load-compaction and enrichment with erosional products from adjacent Precambrian areas. The decrease in electrical resistance from N. to S. on the whole repeats the tectonics of the upper structural plan, the higher values of resistance corresponding to uplifted areas, and low values to depressions. The magnetic properties of the sediments and the possible origin of their magnetic components are also mentioned. It is assumed that the broad positive anomalies of the Kuybyshev Trans-Volga area are due to magnetic sediments filling ancient depressions in the basement while weak magnetic properties are characteristic for the sediments and for the basement in areas of ancient projections of the Precambrian granites and gneisses.--C. Voûte.

7. GEOCHEMISTRY

See also: Mineralogy 2-2339, 2-2364, 2-2365, 2-2366; Igneous and Metamorphic Petrology 2-2375 through 2-2379; Geohydrology 2-2390; Mineral Deposits 2-2391 through 2-2395, 2-2400, 2-2401, 2-2406, 2-2407, 2-2410; Fuels 2-2431, 2-2434.

2-2285. Smales, A.A., and L.R. Wager, eds. METHODS IN GEOCHEMISTRY: 464 p., illus., diags., graphs, tables, New York, Interscience Publishers, Inc., 1960, approx. 800 refs.

The result of a collaborative effort between geologists and chemists, each with a real interest in geochemistry. It is hoped that chemists working in the borderline field of geochemistry will find the more geological parts of the book of value and that geologists wishing to know how analytical data are obtained, or planning to obtain them themselves, will find it of value in estimating the significance of data or in selecting methods. It is also intended that students in the later stages of geological, geochemical, and analytical chemistry courses will be able to get an over-all picture of the many new analytical methods which are rapidly increasing the amounts of fundamental information about the composition of the earth as a whole and of its major parts.--From introd., p. 3.

Contents:

Smales, A.A., and L.R. Wager. Introduction, p. 1-3.

Wager, L.R., and G.M. Brown. Collection and Preparation of Material for Analysis, p. 4-32.

Vincent, E.A. Analysis by Gravimetric and Volumetric Methods, Flame Photometry, Colorimetry and Related Techniques, p. 33-80.

Taylor, S.R., and L.H. Ahrens. Spectrochemical Analysis, p. 81-110.

Shalgosky, H.I. Fluorescent X-ray Spectrography, p. 111-147.

Mayne, K.I. Stable Isotope Geochemistry and Mass Spectrometric Analysis, p. 148-201.

Webster, R.K. Mass Spectrometric Isotope Dilution Analysis, p. 202-246.

Moorbath, S. Radiochemical Methods, p. 247-296.

Mapper, D. Radioactivation Analysis, p. 297-357.

Moorbath, S. Polarography, p. 358-388.

Cornish, F.W. Some Modern Chemical Separation Methods, p. 389-434.

2-2286. Bastron, Harry, Paul R. Barnett, and K.J. Murata. METHOD FOR THE QUANTITATIVE, SPECTROCHEMICAL ANALYSIS OF ROCKS, MINERALS, ORES, AND OTHER MATERIALS BY A POWDER D-C ARC TECHNIQUE: U.S. Geol. Survey, Bull. 1084-G, p. 165-182, 3 tables, 1960, 19 refs.

A method for the quantitative spectrochemical analysis of rocks, minerals, ores, and other materials by a powder d-c arc technique is given. The method is especially valuable for the determination of those constituents that occur at low concentrations. Matrix effects between samples and standards are minimized by making dilutions with a common base material. The total-energy method is used because of the large number of elements found in the analysis of geologic materials. Plate calibration permits the construction of analytical curves that relate the logarithm of the intensity to the logarithm of the concentration. Analysis lines with the concentration ranges of the analytical curves are given. Examples of precision of the method are included.-- Auth.

2-2287. Thompson, C.E., and H.M. Nakagawa. SPECTROPHOTOMETRIC DETERMINATION OF TRACES OF LEAD IN IGNEOUS ROCKS: U.S. Geol. Survey, Bull. 1084-F, p. 151-164, 6 graphs, 4 tables, 1960, 9 refs.

A method for the reliable determination of traces of Pb has been developed to overcome the inadequacy of existing dithizone methods for the determination of Pb in mafic igneous rocks that contain relatively arge amounts of Fe, Zn, and certain alkaline earths. n this method, interferences from these elements re overcome without using special equipment or ime-consuming separation techniques.

Ferric dithizonate has been extracted from alkaline solutions and observed to exhibit a maximum absorbance at 435 millimicrons. This dithizonate of Fe has prevented accurate determinations in our aboratory of Pb in mafic igneous rocks containing 0% or more Fe.

A simple extraction of iron and zinc thiocyanates rom an acid solution with ethyl acetate separates he Fe and Zn from the Pb, eliminating any possible nterference from these elements. The precipitation of calcium or magnesium phosphate and of aluminum hydroxide that otherwise would occur at the optimum pH for the dithizone extraction of Pb is prevented by using a sample solution that contains 20% ammonium citrate. The method permits the determination of 1 part per million of Pb in igneous rocks.--Auth.

2-2288. Fleischer, Michael. THE GEOCHEMISTRY OF RHENIUM - ADDENDUM: Econ. Geology, v. 55, no. 3, p. 607-609, 3 tables, May 1960, 4 refs.

Two recent publications from the U.S.S.R. dealing with the analysis and distribution of Re are briefly described and over 300 Re analyses therein given in tabular form. The data confirm the possibility that systematic study might turn up a source of Re not now guessed.--J. A. Chamberlain.

2-2289. Fujii, Takashi. CORRELATION OF SOME PHYSICAL PROPERTIES AND CHEMICAL COMPOSITION OF SOLID SOLUTION: Am. Mineralogist, v. 45, no. 3/4, p. 370-382, diag., March-Apr. 1960, 15 refs.

The tacit assumption for the linear correlation of he density and the chemical composition of a solid solution is twofold: one is an ideal solid solution and he other identical or nearly identical molar volumes of the components. In an ideal solid solution, the difference in densities obtained by the nonlinear and linear treatments are discussed. These are applied o the spessartite-almandite, almandite-pyrope, orsterite-fayalite and wurtzite-greenockite systems. The garnet systems can be treated practically by the linear correlation, but the olivine and the wurtzite systems must be treated with caution. Coefficients of thermal expansion and compressibilities of the ideal solid solution can be discussed in the same manner. But when the solid solution is ideal, the linear correlation of molar heat capacities and chemical composition is possible. The linear correlation of refractive index and chemical composition of an isotropic solid solution can be derived from the Gladstone-Dale equation, but it is required that the system must be ideal and the molar volumes of the components are equal or nearly equal. If the concept of he volume fraction is introduced, density, coefficient of thermal expansion, compressibility, and refractive index can be correlated linearly with the volume fraction in an ideal system.--Auth.

2-2290. Wernick, J.H. CONSTITUTION OF THE $AgSbS_2$-PbS, $AgBiS_2$-PbS, AND $AgBiS_2$-$AgBiSe_2$ SYSTEMS: Am. Mineralogist, v. 45, no. 5/6, p. 591-598, 8 diags., 3 tables, May-June 1960, 15 refs.

Complete series of solid solutions with the disordered NaCl-type structure exist in the pseudo-binary $AgSbS_2$-PbS and $AgBiS_2$-PbS systems. Thus, synthetic compositions corresponding to the minerals freieslebenite and diaphorite in the $AgSbS_2$-PbS system have high temperature forms with the disordered NaCl structure. Only this cubic form was obtained for the composition corresponding to the mineral schermirite in the $AgBiS_2$-PbS system. Lattice constants as a function of composition for the cubic phase are presented. Negative departures from Vegard's law occur, similar to those observed in the $AgSbSe_2$-$AgSbTe_2$-$AgBiSe_2$-PbTe-PbSe system. The locus of temperatures and compositions for the order-disorder transition in these systems has been determined. The form of the phase diagram for the $AgSbS_2$-PbS system and published structure data for $AgSbS_2$, diaphorite, and freieslebenite indicate that all of the ordered solutions are related.

The high and low temperature modifications of $AgBiS_2$ and $AgBiSe_2$ form a complete series of solid solutions. The phase diagram for this system has been determined. Lattice constants as a function of composition for the cubic phase follow Vegard's law and this is presumed to be the case for the low temperature form.--Auth.

2-2291. Van Hook, H.J. THE TERNARY SYSTEM Ag_2S-Bi_2S_3-PbS: Econ. Geology, v. 55, no. 4, p. 759-788, illus., 15 diags., 5 tables, June-July 1960, 37 refs.

Phase equilibria in the systems Bi-S, Ag_2S-PbS, Ag_2S-Bi_2S_3, PbS-Bi_2S_3, $AgBiS_2$-PbS, and Ag_2S-Bi_2S_3-PbS have been studied by thermal analysis and quenching methods. The high solid solubility of Bi and Ag in the synthetic galena-type structures is correlated with the common occurrence of these elements in natural galena.--Auth.

2-2292. Boyle, R.W. SOME GEOCHEMICAL CONSIDERATIONS ON LEAD-ISOTOPE DATING OF LEAD DEPOSITS: Econ. Geology, v. 55, no. 4, p. 840-841, June-July 1960.

Reply to a discussion of a paper by R.D. Russell (GeoScience Abstracts 1-1950). The writer's use of the term fractionation has been in its broadest sense so as to include all processes leading to the separation of Pb isotopes. There is reason to suspect that physico-chemical fractionation of Pb isotopes takes place in nature. Whether age values refer to the time Pb was released from its source rock or to the time it was deposited as a Pb mineral is of minor significance.--J. A. Chamberlain.

2-2293. Campbell, A.S., and W.S. Fyfe. HYDROXYL ION CATALYSIS OF THE HYDROTHERMAL CRYSTALLIZATION OF AMORPHOUS SILICA; A POSSIBLE HIGH TEMPERATURE pH INDICATOR: Am. Mineralogist, v. 45, no. 3/4, p. 464-468, 3 tables, March-Apr. 1960, 11 refs.

Ignited silicic acid was sealed in a silver tube with 0.1 ml. of carbonate free sodium hydroxide. The molar ratio of silica to hydroxide was always about 100. The tube was placed in a 1.5 ml. stainless steel test-tube bomb and heated to 245°C. Cristobalite appeared first and was well developed before quartz appeared. The change from cristobalite to quartz was much faster than that from amorphous silica to cristobalite. Tridymite and silica-K were not detected. The minimum time for the complete formation of quartz with NaOH concentrations of 0.100, 0.017, and 0.012 Molar were 20, 110 and 140 hours respectively. This time is a linear function of 1/[NaOH].

The hydroxyl ions accelerate the polymerization of silicate ions in solution and the rate of quartz formation probably is proportional to the $H_3SiO_4^-$ or singly charged silicate anion concentration. This time may be useful as a pH indicator in more complicated environments and the catalyzing action may be used to reduce time for equilibrium in silicate systems by factors of hundreds and thousands.--D.O. Emerson.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Geomorphology 2-2224; Sedimentary Petrology 2-2382.

2-2294. Patterson, A.L., and Warner E. Love. ERROR ANALYSIS FOR THE BUERGER PRECESSION CAMERA: Am. Mineralogist, v. 45, no. 3/4, p. 325-333, table, March-Apr. 1960, 10 refs.

A routine for the reduction of the data from precession X-ray diffraction photographs leads to a direct estimate of the reliability of the cell constants calculated from such measurements. Calibration routines are also discussed.--Auth.

2-2295. Weaver, C.F., and T.N. McVay. IMMERSION OILS WITH INDICES OF REFRACTION FROM 1.292 TO 1.411: Am. Mineralogist, v. 45, no. 3/4, p. 469-470, table, March-Apr. 1960, 8 refs.

Mixtures of the commercially available perfluorotributylamine, $(C_4F_9)_3N$, [$n_D^{25^\circ C.}$=1.292] and polymers of chlorotrifluoroethylene, known as KEL-F$^{(R)}$ Polymer Oil No. 10 [$n_D^{25^\circ C.}$=1.411] or the less viscous fifth member of the chlorotrifluoroethylene series $Cl\text{-}(CF_2\text{-}CFCl)_5\text{-}Cl$, [$n_D^{25^\circ C.}$=1.406] are used extensively for low index immersion oils. These mixtures are nontoxic, inert, colorless, odorless, and stable.--D.O. Emerson.

2-2296. Futergendler, S.I. X-RAY STUDY OF SOLID INCLUSIONS IN DIAMONDS: Kristallografiya [in translation], v. 3, no. 4, p. 494-497, 7 illus., 2 tables, July-Aug. 1958, pub. 1959, 7 refs.

The following inclusions were found: garnet, olivine, diopside, chromospinellide, and diamond.--Auth.

2-2297. Belov, K.P., and A.V. Zalessky. THERMAL EXPANSION AND MAGNETOSTRICTION OF PYRRHOTITE: Kristallografiya [in translation], v. 3, no. 3, p. 390-392, 2 figs., May-June 1958, pub. 1959, 5 refs.

Curves are presented showing the relationship between temperature (maximum of 350°C.) and specific magnetization, magnetostriction, relative elongation, and coefficient of thermal expansion. The thermal expansion curve shows a sharp maximum at 320°C.; this and other smaller anomalies on the thermal expansion, magnetostriction, and magnetization curves are caused by the energy and volume changes resulting from the ordering of structural vacancies.--E.G. Ehlers.

2-2298. Sunagawa, Ichiro. GROWTH HISTORY OF HEMATITE: Am. Mineralogist, v. 45, no. 5/6, p. 566-575, 6 illus., 2 tables, May-June 1960, 5 refs.

On one crystal of hematite from Japan, the whole final history of growth, from 2-dimensional nucleation to spiral growth and the movement of dislocations after growth has ceased, is observed. The end growth history is explained.

Measurements of the step heights made with precision multiple-beam interference show the existence of a growth island formed by 2-dimensional nucleation. This has a height of a few units plus a fraction of the unit cell. The step of a spiral growth layer is shown to be a half unit cell. This is a rare feature in crystal growth. The mechanism of the formation of growth islands is also discussed.--Auth.

2-2299. Kondrashev, Yu. D. THE CRYSTAL STRUCTURE AND COMPOSITION OF CREDNERITE, $CuMnO_2$: Kristallografiya [in translation], v. 3, no. 6, p. 703-706, 2 figs., table, Nov.-Dec. 1958, pub. Jan. 1960, 12 refs.

The parameters of the monoclinic cell of synthetic crednerite have been refined. The formula $CuMnO_2$ assumed on the basis of crystal chemistry has been confirmed by the determination of the density and an analysis of the intensities of the lines. The structure of $CuMnO_2$ has been found to consist of alternating layers of O octahedra and trigonal prisms. The Mn^{+3} ions lie in the centers of the octahedra; the Cu^{+1} ions, on the midpoints of the vertical edges of the prisms.--Auth.

2-2300. Pyatenko, Yu. A. SOME ASPECTS OF THE CHEMICAL CRYSTALLOGRAPHY OF THE PYROCHLOR-GROUP MINERALS: Kristallografiya [in translation], v. 4, no. 2, p. 184-186, 2 diags., March-Apr. 1959, pub. Feb. 1960, 5 refs.

The minerals of the pyrochlore group have the idealized formula $A_2B_2X_7$, where A is Na, Ca, Th, U, or rare earths, B is Nb, Ti, and X is O, or less commonly OH, or F. There is often a deficiency of group A cations.

The pyrochlore group is commonly found in the metamict state. This is probably a result of anion defects; in most ionic crystals the cation array can change widely without affecting the stability of the structure.

The pyrochlore structure can be derived from the structure type of fluorite, which is analogous to a 3-dimensional chess-board arrangement of alternating cubes and open areas. This would be similar to using only the black or red squares in the chess-board. In the 3-dimensional analogy, 4 cubes meet at each corner. The pyrochlore group has a similar spacial arrangement, but consists of alternating cubes and flattened octahedra. Thus 2 cubes and 2 octahedra intersect at each polyhedra corner. Group A, consisting of the larger cations is in cubic coordination, whereas group B is in octahedral coordination.

The number of O atoms in the structure varies as a function of the type of cations which are present (as in the series Ce_4O_8 to Sb_4O_6). Hence the ratio of cubes to octahedra need not remain fixed. As the umber of octahedra increases with respect to the ubes, large holes are formed in the anion structure. ncreasing instability of this type causes the struc-ure to become metamict. Extra holes which are aused by replacements $2Ca^{+2} \rightarrow U^{+4}$ also make the tructure open and unstable.

This agrees with the observation that pyrochlore ninerals which are highly deficient in A cations and ontain much U^{+4}, Th^{+4}, or rare earths are usually netamict. X-ray data indicate the degree to which hese minerals are in the metamict state.--E.G. hlers.

-2301. Shaskolskaya, M.P., and Sun Jui-fang. N THE MECHANISM OF PLASTIC DEFORMATION F ROCK SALT CRYSTALS: Kristallografiya [in ranslation], v. 4, no. 1, p. 68-73, 10 figs., Jan.-eb. 1959, pub. Jan. 1960, 12 refs.

The formation of birefringent bands under uniform ompression and tension in single rock salt crystals s correlated with the relief which forms on the side aces of the crystal as investigated with a microinter-erometer. It is shown that during the initial stages f plastic deformation the birefringent bands are aused by gliding. Corresponding to each band there re steps on the side faces, and the heights of the teps on the opposite sides of the crystal are always ifferent. The crystal is under tension on one side f a band and under compression on the other. The esulting residual stresses are the cause of bire-ringence.--Auth.

-2302. Rais, G.B. DISTORTION OF THE CRYS-AL LATTICE ON THE TWIN BOUNDARY OF A ECHANICALLY TWINNED CALCITE CRYSTAL: Kristallografiya [in translation], v. 3, no. 3, p. 328-31, 6 illus., May-June 1958, pub. 1959, 10 refs.

The distortion of the crystal lattice near the twin oundary of a mechanically twinned calcite crystal as been investigated by measuring the solubility of he face parallel to the slip plane. The dimensions f the distorted region have been ascertained.--Auth.

-2303. Kolontsova, E.V., Yu. G. Sorokina, and .V. Telegina. STUDY OF TWINNING IN CALCITE RYSTALS BY MEANS OF AN X-RAY MICRO-BEAM ND ETCH FIGURES: Kristallografiya [in transla-ion], v. 4, no. 5, p. 702-708, 11 illus., Sept.-Oct. 959, pub. May 1960, 11 refs.

Laue photographs were taken of different parts of calcite crystal which had been mechanically de-ormed by twinning. Successive etching of the twin oundaries indicates that the disturbed structure has magnitude of 10^{-6} to 10^{-7} cm. The boundary be-ween the twin and the original crystal is formed by islocations. A more detailed examination of the haracter of the contact of the parent crystal with the win requires the use of narrower X-ray beams about 1 μ).--E.G. Ehlers.

-2304. Vinokurov, V.M. ON THE NATURE OF HE MAGNETIC PROPERTIES OF SIDERITE, AN-ERITE AND RHODOCHROSITE: Kristallografiya in translation], v. 3, no. 5, p. 606-610, 5 tables, ept.-Oct. 1958, pub. Dec. 1959, 10 refs.

The magnetic susceptibility of siderite, ankerite, and rhodochrosite was studied by the method of Jous-sot-Dubien, Lemanceau, and Pacault. The results indicate that siderite, ankerite, and rhodochrosite are paramagnetic. Siderite and ankerite are magnetically anisotropic, and rhodochrosite is magnetically isotropic. The axis of easiest magnetization for siderite and ankerite coincides with the C direction.

The magnetic properties of the carbonates studied are determined by the nature of the principal paramagnetic ion and the crystal structure of the mineral. In the case of similar structures (siderite, ankerite, Fe and Mn calcite and dolomite), the magnitude of the magnetic susceptibility is proportional to the number of paramagnetic ions in the structure. This circumstance indicates that magnetic measurements can be used for purposes of chemical analysis and identification of minerals.--E.G. Ehlers.

2-2305. Simonov, V.I., and N.V. Belov. THE DETERMINATION OF THE STRUCTURE OF AMBLYGONITE BY THE MINIMUM-FUNCTION METHOD: Kristallografiya [in translation], v. 3, no. 4, p. 429-438, 6 figs., 3 tables, July-Aug. 1958, pub. 1959, 21 refs.

A complete analysis of the structure of the lithium phosphate amblygonite, $LiAlPO_4F$, has been carried out by the superposition method. A comparison is made of the resolving power of the various functions, which makes it possible to clarify the crystallochemical nature of the part played by the Li.--Auth.

2-2306. Pavlov, P.V., and N.V. Belov. THE STRUCTURES OF HERDERITE, DATOLITE AND GADOLINITE DETERMINED BY DIRECT METHODS: Kristallografiya [in translation], v. 4, no. 3, p. 300-314, 8 figs., 3 tables, May-June 1959, pub. March 1960, 19 refs.

The direct methods developed at the Institute of Crystallography [Academy of Sciences, U.S.S.R.] and at Gorky University have proved exceptionally powerful in solving the structures of the 3 minerals. A detailed exposition of the solution is given with illustrations of the use of Harker-Kasper inequalities and of statistical analysis of Zachariasen's methods.

Herderite $CaBePO_4F$ is of special interest because it contains Be (15.3 wt. % BeO, as against 14% BeO in beryl). Strunz has supposed that herderite has a structure very like that of datolite $CaBSiO_4(OH)$, which Ito and Mori have examined by the (half) heavy-atom method; the 2 should form a good example of how ions of equal size but different valency, having the same sum of all valencies for the groups (pairs), may replace one another to give the same structure:

$$\begin{matrix} CaBSiO_4\,(OH) \\ CaBePO_4F. \end{matrix}$$

Gadolinite contains also Fe^{++} : datolite is $Ca_2B_2(OH)_2$-Si_2O_3, while gadolinite is $Fe^{++}\,Y_2Be_2O_2Si_2O_8$.--Auth.

2-2307. Rumanova, I.M., and G.I. Malitskaya. REVISION OF THE STRUCTURE OF ASTRAKHANITE BY WEIGHTED PHASE PROJECTION METHODS: Kristallografiya [in translation], v. 4, no. 4, p. 481-495, 4 illus., 6 tables, July-Aug. 1959, pub. Apr. 1960, 13 refs.

Astrakhanite is monoclinic and its unit-cell parameters are $a = 11.03$, $b = 8.14$, $c = 5.49$ A, $\beta = 100°39'$; the cell contains two $Na_2Mg(SO_4)_2 \cdot 4H_2O$ units, and the space group is $C_{2h}^5 = P2_1/a$. The structure has been derived by means of electron-density projections after the signs of the structure factors have been found by statistical methods. The coordinates have been revised by using weighted phase projection methods on the electron density.

The structure consists of nets of Mg and Na octahedra parallel to xy; the nets are joined by SO_4 tetrahedra along z.--Auth.

2-2308. Komkov, A.I. THE STRUCTURE OF NATURAL FERGUSONITE, AND OF A POLYMORPHIC MODIFICATION: Kristallografiya [in translation], v. 4, no. 6, p. 796-800, 4 figs., 2 tables, Nov.-Dec. 1959, pub. June 1960, 7 refs.

Structure studies are reported for fergusonite from the central Urals, and for a polymorphic form produced by heating the mineral to over 1,000°C. and allowing it to cool to room temperature.

Fergusonite from the central Urals falls in the Laue class $C_{4h} = 4/m$; it has cell parameters a = 5.16 A and c = 10.89 A, and the cell contains 4 units (Y, Yb)NbO_4 (Y = 0.85; Yb = 0.15).

X-ray studies on fergusonite heated to 1,000°C. for 15 min. and then cooled to room temperature show that the mineral goes over to a monoclinic form, whose parameters are a = 5.05 A, b = 10.89 A, c = 5.27 A, and $\beta = 85^{\circ}30'$ ($94^{\circ}30'$); the cell contains four (Y, Yb)NbO_4 units.--From auth., p. 796, 797.

2-2309. Batrak, E.N. A MODEL FOR THE COLOR AND LUMINESCENCE CENTERS IN QUARTZ: Kristallografiya [in translation], v. 3, no. 5, p. 633-634, 3 figs., Sept.-Oct. 1958, pub. Dec. 1959, 5 refs.

Alkali-metal ions form electron traps in quartz. Electrons caught in these traps result in the formation of the additional absorption bands which are associated with smoky quartz. Li and Na ions compensate the charge defects caused by replacement of Si by Al and cause the color centers produced by ionizing radiation.

Both Li and Na ions produce an emission spectrum consisting of one band in the blue region with a maximum at 445 $m\mu$. A model is described in which it is considered that the Al ions which replace Si act in a manner which is similar to activators in phosphors.

Inasmuch as the emission from smoky quartz does not depend on the nature of the compensating ions, it is assumed that the color and luminescence centers lie at different points.--E.G. Ehlers.

2-2310. Afanaseva, N.A., I.E. Kamentsev, and V.A. Frank-Kamenetsky. VARIATION OF THE ELEMENTARY CELL PARAMETERS OF QUARTZ OF DIFFERENT SOURCES: Kristallografiya [in translation], v. 4, no. 3, p. 354-357, illus., diag., 2 tables, May-June 1959, pub. March 1960, 12 refs.

The results are given of a precision X-ray analysis of 10 specimens of natural quartz from different types of deposit. The parameters have been determined with an accuracy of $\pm$ 0.0002A by the focusing back-reflection method using camera RKÉ. A variation of the parameter a, from 4.9121 to 4.9137A and parameter c, from 5.4031 to 5.4051A, was found. Comparison with the results of spectrum analysis indicates the dependence of the volume of the elementary cell of quartz on the content of impurities (Al, R^{+}, R^{++}).--Auth.

2-2311. Ribbe, Paul H. AN X-RAY AND OPTICAL INVESTIGATION OF THE PERISTERITE PLAGIOCLASES: Am. Mineralogist, v. 45, no. 5/6, p. 626-644, illus., 6 diags., 6 tables, May-June 1960, 28 refs.

Low-temperature plagioclase feldspars in the peristerite range $An_{5\pm 2}$ to $An_{17\pm 2}$ unmix on a submicroscopic scale to relieve internal stresses created by substituting Al for Si in the tetrahedral framework. The unmixed components are An_{0-6} and An_{20-35}, averaging An_3 and An_{25} respectively. Most peristerites exhibit a bluish schiller as a result of diffusion of light by the submicroscopic domains of different optical polarizabilities. The optical properties of the crystal are weighted averages of those of the domains. Heating at 1,000°C. causes disordering of Na and Ca between domains, followed by disordering of Si and Al within domains, and final homogenization by disordering of Si and Al between domains. Schiller is retained until the final step of homogenization. Homogenization cannot be studied by simple X-ray methods, owing to similarity in unit cell geometry of the high-temperature phases, but can be followed by optic angle measurements. An X-ray technique has been developed to determine the composition of individual unmixed grains, and has been applied to confirm the presence of a break or flexure in the plagioclase refractive index curves near An_5-An_7, the lower limit of the peristerite region. The upper limit of the peristerite region has not been studied in detail, but deviations from the albite structure sufficient to incorporate the additional Al-content are inferred.--Auth.

2-2312. Vinokurov, V.M., and M.M. Zaripov. THE MAGNETISM OF TOURMALINE: Kristallografiya [in translation], v. 4, no. 6, p. 828-831, 3 tables, Nov.-Dec. 1959, pub. June 1960, 14 refs.

Tourmaline falls into 2 classes on the basis of differences in magnetic properties - those of high susceptibility and large anisotropy, and those in which both parameters are small. The magnetic parameters are related to the type and amounts of cations present. The relationships between the various colors of tourmaline and nature of the cations present are discussed in some detail.--E.G. Ehlers.

2-2313. Simonov, V.I., and N.V. Belov. THE DETERMINATION OF THE STRUCTURE OF SEIDOZERITE: Kristallografiya [in translation], v. 4, no. 2, p. 146-157, 2 illus., 3 diags., 2 graphs, 3 tables, March-Apr. 1959, pub. Feb. 1960, 21 refs.

The crystal structure of the Zr-Ti silicate seidozerite has been elucidated by superposition on the (x, z) Patterson projection and by statistical determination of the signs of the F_{0kl} reflections. From the structure the expanded chemical formula of seidozerite is given as $Na_4MnTi(Zr_{1,5}Ti_{0,5})O_2(F, OH)_2[Si_2O_7]_2$ and its diorthosilicate nature (containing the group Si_2O_7) is revealed, despite the orthosilicate stoichiometric formula.--Auth.

2-2314. Rumanova, I.M., and T.V. Nikolaeva. CRYSTAL STRUCTURE OF ORTHITE: Kristallografiya [in translation], v. 4, no. 6, p. 789-795, 3 illus., diag., 3 tables, Nov.-Dec. 1959, pub. June 1960, 9 refs.

Orthite $(Ca, Ce, La, Na, Mn^{++})_2(Al, Fe, Mg)_3Si_3O_{12}(OH, O)$ possesses the structural motif of epidote $Ca_2(Al, Fe^{+++})Al_2O(OH)[Si_2O_7][SiO_4]$, but has the interesting peculiarity that, of the 2 crystallographically independent atoms of Ca in the structure of epidote, only one (namely, the one in the "looser" O polyhedron) is isomorphously replaced by a Ce atom in orthite. At the same time, part of he Fe^{+++} cations are replaced by Fe^{++} cations. The detailed formula for orthite is thus CaCe (Fe^{++}, Fe^{+++})$Al_2O(OH, O) [Si_2O_7] [SiO_4]$.

The absence of cleavage in orthite is well explained by the regular replacement of part of the Ca by Ce, and in this respect it differs markedly from epidote, in which there is perfect cleavage along (001) and imperfect cleavage along (100).--Auth.

2-2315. Pyatenko, Yu. A., and Z.V. Pudovkina. ON THE CRYSTAL STRUCTURE OF NARSARSUKITE: Kristallografiya [in translation], v. 4, no. 6, p. 885-886, diag., Nov.-Dec. 1959, pub. June 1960, 2 refs.

An X-ray examination on narsarsukite $Na_2(Ti, Fe)(O, OH)[Si_4O_{10}]$ confirms earlier published studies. The unit cell is tetragonal with a = 10.72, c = 7.99A and z = 4. The space group is C_{4h}^5 - I4/m.--E.G. Ehlers.

2-2316. Nudelman, S.L. THE LATTICE PARAMETERS OF CHRYSOTILE: Kristallografiya [in translation], v. 4, no. 4, p. 581-583, diag., table, July-Aug. 1959, pub. Apr. 1960, 7 refs.

A method of deriving cell parameters of monoclinic crystals from X-ray powder patterns is described. Gruner's results on the parameters of chrysotile have been recalculated and give the following values: a = 9.068, b = 6.715, c = 8.089 Å, β = 62°.--E.G. Ehlers.

2-2317. Zevin, L.S., and M.S. Leizerzon. THE PROBLEM OF THE POSITION OF THE POTASSIUM ION IN MICA STRUCTURE: Kristallografiya [in translation], v. 4, no. 3, p. 395-396, fig., May-June 1959, pub. March 1960, 4 refs.

An electron density projection was plotted for 3 specimens of phlogopite on the Z axis, perpendicular to the silica and magnesia layers. It was concluded that the K ions are symmetrical with respect to the layers. The K ions intrude the layers until they touch an O ion. Agreement between the model given for the structure of mica and the ion radii should not be on the basis of a change in the parameter of K^+, but on the basis of deformation of the lattice of the silica tetrahedra.--E.G. Ehlers.

2-2318. Williams, K.L. AN ASSOCIATION OF AWARUITE WITH HEAZLEWOODITE: Am. Mineralogist, v. 45, no. 3/4, p. 450-453, illus., 2 tables, March-Apr. 1960, 9 refs.

High-grade heazlewoodite ore from the Lord Brassey mine, Heazlewood, Tasmania, contains, along with magnetite, "net-like" intergrowths less than 0.3 mm. wide of the Ni-Fe alloy, awaruite. When compared with analyzed New Zealand awaruite, it is found that cell parameters are only a crude estimate of the composition. X-ray powder and microscopic data are given.--D.O. Emerson.

2-2319. Skinner, Brian J., and Paul B. Barton, Jr. THE SUBSTITUTION OF OXYGEN FOR SULFUR IN WURTZITE AND SPHALERITE: Am. Mineralogist, v. 45, no. 5/6, p. 612-625, fig., 4 tables, May-June 1960, 14 refs.

Small amounts of O can substitute for S in wurtzite and sphalerite. The maximum amount of O found in synthetic sphalerite in this study is 0.7 weight per cent ZnO compared to a maximum of 1.0 weight per cent ZnO in wurtzite (Kroeger and Dikhoff). The addition of 0.7 weight per cent ZnO to sphalerite reduces the unit cell edge from 5.4093 ± 0.0002 Å to 5.4065 ± 0.0003 Å. This decrease explains the discrepancy between unit cell measurements on "pure" sphalerite made by various workers.

O was found in ZnS precipitated by passing H_2S gas through an aqueous solution of $ZnSO_4$ at room temperature. O can be added to pure ZnS by heating ZnS with ZnO. The O can be removed by heating the Zn(S, O) with excess S or with an O getter such as metallic Mg.

X-ray analysis of a few natural sphalerites supports calculations that show that the amount of O present in sphalerite under equilibrium conditions should be below the limits of analytical detection.--Auth.

2-2320. Carroll, Dorothy. ILMENITE ALTERATION UNDER REDUCING CONDITIONS IN UNCONSOLIDATED SEDIMENTS: Econ. Geology, v. 55, no. 3, p. 618-619, May 1960, 6 refs.

Discussion of a paper by J.W. Gruner (GeoScience Abstracts 1-3102). Nonmarine Cretaceous sediments in the Maryland Coastal Plain contain authigenic rutile, pyrite, and siderite. The presence of siderite and pyrite indicate a redox potential of between -0.1 and -0.3. The pH was about 3 - 4 because many of the clays are now acid. The alteration of ilmenite to rutile and pyrite accounted for only a small part of the total pyrite. Certain bauxites formed in reducing conditions also contain authigenic minerals --J.A. Chamberlain.

2-2321. Karkhanavala, M.D. ALTERATION OF ILMENITE AND "ARIZONITE": Econ. Geology, v. 55, no. 4, p. 843-844, June-July 1960.

Discussion of a paper by B.H. Flinter (GeoScience Abstracts 1-1752). Leucoxene, not arizonite, should be retained as the generic name for alteration products of ilmenite. Arizonite represents a finite chemical compound, ferric metatitanate. The conclusion that pseudobrookite is unstable at high temperatures is unfounded. The absence of pseudobrookite in fully altered grains is probably due to its physical loosening and eventual removal.--J.A. Chamberlain.

2-2322. Bilgrami, S.A., and C. Oliver Ingamells. CHEMICAL COMPOSITION OF THE ZHOB VALLEY CHROMITES, WEST PAKISTAN: Am. Mineralogist, v. 45, no. 5/6, p. 576-590, map, 2 diags., 7 tables, May-June 1960, 15 refs.

Two complete and 22 partial chemical analyses of chromites from the Hindubagh-Nasaï area in West Pakistan are given, and their chemical composition is discussed. It is suggested that the chromites showing a Cr/Fe ratio greater than 3:1 are earlier in age than those showing a lower ratio. A new method for the complete chemical analysis of chromite is described.--Auth.

2-2323. Heinrich, E. Wm., and Eugene B. Gross. FLUOCERITE AND ASSOCIATED MINERALS FROM THE BLACK CLOUD PEGMATITE, TELLER COUNTY, COLORADO: Am. Mineralogist, v. 45, no. 3/4, p. 455-459, illus., 3 tables, March-Apr. 1960, 5 refs.

With accessory minerals of the Ce-group as well as the Y-group elements, the Black Cloud deposit near Divide, Colorado, is unique for the area. This lensoid pegmatite in the Pikes Peak granite measures 350 x 110 ft. and is sharply zoned with a 50 ft. thick quartz core. Irregular fluoritic and albitic replacement lenses, about 4 ft. long, contain allanite, gadolinite, thorite, beryl, bertrandite, smarskite, yttrotantalite, fergusonite, monazite, xenotime, fluocerite, and 3 types of fluorite. This is the second recorded occurrence of fluocerite and yttrotantalite. X-ray, chemical, and microscopic data are given for fluocerite.--D. O. Emerson.

2-2324. Huang, C.K., and Paul F. Kerr. INFRARED STUDY OF THE CARBONATE MINERALS: Am. Mineralogist, v. 45, no. 3/4, p. 311-324, 6 figs., 7 tables, March-Apr. 1960, 20 refs.

Infrared spectra of 27 common and rare carbonates are described. Each carbonate shows characteristic absorption bands, some of which differ more or less from published curves. Among the isomorphous members of the calcite, dolomite, and aragonite groups, a noteworthy shift of absorption bands takes place with longer wave lengths corresponding to an increase in cation radius or mass. The spectral difference between the more common groups may be related to crystal structure. The spectral relationships among the minerals of several groups are not well known, due to the complicated composition and crystal structure. Infrared active groups of CO_3, HCO_3, H_2O, OH, and SO_4 dominate the absorption characteristics.--Auth.

2-2325. Christ, C.L. CRYSTAL CHEMISTRY AND SYSTEMATIC CLASSIFICATION OF HYDRATED BORATE MINERALS: Am. Mineralogist, v. 45, no. 3/4, p. 334-340, 2 tables, March-Apr. 1960, 33 refs.

A systematic classification is made of hydrated borates of known crystal structures, based upon the structures of the complex B-O polyions contained in these crystals. From considerations of these known polyanion structures, 4 rules are deduced governing the nature of such polyanions. The structural formulas of a number of hydrated borates of known composition, but of unknown crystal structure, are predicted from the application of these rules and other reasonable crystal-chemical arguments.--Auth.

2-2326. Leonard, B.F., and Angelina C. Vlisidis. VONSENITE FROM ST. LAWRENCE COUNTY, NORTHWEST ADIRONDACKS, NEW YORK: Am. Mineralogist, v. 45, no. 3/4, p. 439-442, 2 tables, March-Apr. 1960, 12 refs.

The name vonsenite should replace paigeite as the $Fe_2''Fe'''BO_5$ end-member of the ludwigite-vonsenite series. Vonsenite of nearly end-member composition occurs as a major constituent in part of the magnetite-bearing zone at Jayville, New York. Spectrographic, X-ray powder, and microscopic data are given.--D. O. Emerson.

2-2327. Fisher, D. Jerome, and Alex Volborth. MORINITE-APATITE-WHITLOCKITE: Am. Mineralogist, v. 45, no. 5/6, p. 645-667, illus., 2 diags., graph, 7 tables, May-June 1960, 12 refs.

New chemical analyses of Black Hills, [South Dakota] and French morinites confirm the previously published empirical formula of this rare pegmatite fluorophosphate. Thermal experiments of great quantity and diversity on the Black Hills morinite show that it inverts irreversibly to an apatite structure at about 400°C., whether heated in air or vacuum, and to a whitlockite (rhombohedral tri-calcium phosphate) structure if heated in thin films in air at a bit under 800°. Since these products are rich in Na, F, and Al, they are here dubbed nafalapatites or nafalwhitlockites, and both of these are thought to show a considerable variation in composition.

In spite (or because) of the great quantity of data assembled, the writer is unable to reach an unequivocal interpretation of what happens during the thermal treatment of morinite. Results postulated, including the existence of a nafalapatite containing over 5% Na, 14% F, and 13% Al, seem so unusual as to be suspect; this research leaves many unanswered questions.--Auth.

2-2328. Owens, James P., Z.S. Altschuler, and Robert M. Berman. MILLISITE IN PHOSPHORITE FROM HOMELAND, FLORIDA: Am. Mineralogist, v. 45, no. 5/6, p. 547-561, 6 figs. incl. 2 illus., 4 tables, May-June 1960, 15 refs.

Millisite, $(Na,K)CaAl_6(PO_4)_4(OH)_9 \cdot 3H_2O$, and crandallite, $CaAl_3(PO_4)_2(OH)_5 \cdot H_2O$, are major components of the aluminum phosphate zone of the Bone Valley formation [Pliocene] of W.-central Florida, where they occur as a microcrystalline intergrowth composing the cement in the altered phosphorite. Formerly known only from concretions at Fairfield, Utah, and from the phosphate deposits of Thiès, Sénégal, millisite, like crandallite, is an important phase in the paragenesis of lateritically formed aluminum phosphates.

From optical and X-ray study of the Florida mixture and a comparison with phosphates from other localities, it is shown that the Florida material contains millisite rather than the structurally related wardite. It is found that all 3 known millisites give virtually identical X-ray patterns and that their unit-cell parameters are $\underline{a}_0 = 7.00$ Å and $\underline{c}_0 = 19.07$ Å, which differ from those for wardite.

The aggregate index of refraction of millisite, $\underline{n} = 1.63$, is higher than that reported for type millisite from Fairfield. The aggregate index of refraction of crandallite, $\underline{n} = 1.59 - 1.61$, is in the lower range of known eucrystalline crandallite.--Auth.

2-2329. Nielsen, J.W., and F. Gordon Foster. UNUSUAL ETCH PITS IN QUARTZ CRYSTALS: Am. Mineralogist, v. 45, no. 3/4, p. 299-310, 7 illus., diag., March-Apr. 1960, 14 refs.

Synthetic and natural quartz crystals have been etched in 48% HF in a manner described by Arnold and have been found to exhibit deep etch tubes which are ribbonlike in shape. Examples of these etch tubes are shown and possible explanations for their formation are given.--Auth.

2-2330. Mason, Brian, and L.B. Sand. CLINOPTILOLITE FROM PATAGONIA; THE RELATIONSHIP BETWEEN CLINOPTILOLITE AND HEULANDITE: Am. Mineralogist, v. 45, no. 3/4, p. 341-350, 2 diags., 2 tables, March-Apr. 1960, 8 refs.

Clinoptilolite occurs as a layer 6-8 cm. thick interbedded with bentonitic clays of the Sarmiento formation (Eocene-Oligocene) in the Cañadón Hondo in Argentine Patagonia. Physical and optical data are given for the mineral; its density is 2.11, mean refractive index 1.478, birefringence about 0.001. A chemical analysis indicates a unit cell content of

$(Na, K)_{4.86}(Ca, Mg)_{0.31}Al_{5.49}Si_{30.50}O_{72} \cdot 19H_2O$. The mineral has been formed by diagenetic alteration of volcanic glass in a nonmarine environment.

Comparison of this material with other clinoptilolites, including the original material described by Pirsson and named by Schaller, and with heulandite, shows that clinoptilolite is a distinct species. Clinoptilolite and heulandite have the same structure, but heulandite is essentially a Ca zeolite and clinoptilolite a Na-K zeolite; analyses of the minerals indicate that there is a compositional gap between them. --Auth.

2-2331. Mumpton, Frederick A. CLINOPTILOLITE REDEFINED: Am. Mineralogist, v. 45, no. 3/4, p. 351-369, 7 figs. incl. illus., 2 diags., graph, 2 tables, March-Apr. 1960, 27 refs.

Since its introduction into the literature in 1923, clinoptilolite has been a subject of confusion within the zeolite group of minerals. A critical review is made of papers dealing with the original description of clinoptilolite, its occurrence in the groundmass of altered pyroclastics, and of the arguments favoring its identity with "silica-rich" heulandite.

New experimental data on clinoptilolite from Hector, California, and on other samples from Tertiary sediments assist in the redefinition of this zeolite. Although the powder pattern of clinoptilolite is almost identical with that of heulandite, high temperature X-ray diffraction studies show that at about 230°C., heulandite transforms into "heulandite B," and at 350°C. becomes amorphous. Clinoptilolite, however, remains stable to about 700°C. without reaction at lower temperatures.

The data of chemical, optical, and differential thermal analyses are also employed to redefine clinoptilolite as the high-silica member of the heulandite structural group usually containing monovalent rather than divalent cations, and to retain the name as a valid mineral species on equal status with heulandite.

The enrichment of silica in the clinoptilolite lattice as compared to heulandite is apparently correlatable with its increased thermal stability, and is probably a direct consequence of its origin from altered volcanic glass.--Auth.

2-2332. Ames, L.L., Jr. THE CATION SIEVE PROPERTIES OF CLINOPTILOLITE: Am. Mineralogist, v. 45, no. 5/6, p. 689-700, 13 diags., 3 tables, May-June 1960, 7 refs.

A zeolite was sought for use in columns that would selectively remove Cs from solutions containing large concentrations of competing cations. Clinoptilolite was found to be highly Cs-selective over wide pH, flow rate, and temperature ranges.

Factors affecting clinoptilolite cation selectivities included cation size, charge, electronic structure and, in the presence of Na, temperature. The large Cs capacity, rapid approach to equilibrium, and high Cs selectivity of clinoptilolite are apparent from the data presented.--Auth.

2-2333. Leake, Bernard E. COMPILATION OF CHEMICAL ANALYSES AND PHYSICAL CONSTANTS OF NATURAL CORDIERITES: Am. Mineralogist, v. 45, no. 3/4, p. 282-298, 5 diags., graph, table, March-Apr. 1960, 27 refs.

A brief review of previous attempts to correlate the composition and optical properties of cordierite, followed by a compilation, including 4 new analyses, of 62 chemical analyses of natural cordierites together with their refractive indices, optic angles, and densities.--Auth.

2-2334. Fahey, Joseph J., Malcolm Ross, and Joseph M. Axelrod. LOUGHLINITE, A NEW HYDROUS SODIUM MAGNESIUM SILICATE: Am. Mineralogist, v. 45, no. 3/4, p. 270-281, 3 illus., 3 tables, March-Apr. 1960, 9 refs.

A new hydrous sodium magnesium silicate from the Green River formation [Eocene] in Sweetwater County, Wyoming, having the formula $Na_2O \cdot 3MgO \cdot 6SiO_2 \cdot 8H_2O$, is named after Dr. Gerald F. Loughlin, former Chief Geologist of the U.S. Geological Survey.

The mineral is found in dolomitic oil shale and in thin section has been seen replacing shortite, northupite, and searlesite. Loughlinite is a fibrous, pearly-white mineral with a silky luster and is virtually identical to sepiolite ($4MgO \cdot 6SiO_2 \cdot 8H_2O$), both in hand specimen and microscopically. Loughlinite may be distinguished from sepiolite by the 8% Na_2O in the structure and by comparison of the X-ray fiber diagrams. The indices of refraction of loughlinite are $\alpha = 1.500$, $\beta = 1.505$, and $\gamma = 1.525$.

Prolonged leaching of loughlinite with water or immersion of loughlinite in Mg salt solutions converts the mineral into a material that is apparently identical to sepiolite.--Auth.

2-2335. Maser, Morton, Robert V. Rice, and Harold P. Klug. CHRYSOTILE MORPHOLOGY: Am. Mineralogist, v. 45, no. 5/6, p. 680-688, 3 illus., May-June 1960, 13 refs.

Bundles of chrysotile fibers embedded in "Araldite" were cut with a diamond knife. Electron micrographs showed predominantly circular cross sections, many rings, and also end-on views of concentric tubes. Areas of intermediate electron optical density within tubes and between tubes were seen. The data support the explanation of high density values as being caused by amorphous-appearing material plugging voids, and strongly indicate that chrysotile fibers are tubes in their massive form. The ultramicrotomy method and the electron micrographs obtained are discussed: several unusual morphological features revealed by cutting cross sections are pointed out.--Auth.

2-2336. Wolfe, Caleb Wroe, and I. Vilks. PSEUDOMORPHES [SIC] AFTER DATOLITE, PREHNITE AND APOPHYLLITE FROM EAST GRANBY, CONNECTICUT: Am. Mineralogist, v. 45, no. 3/4, p. 443-447, 4 illus., March-Apr. 1960.

Fine-grained chlorite, partially replacing datolite, prehnite, and apophyllite, occurs with calcite and quartz in shear openings of the Triassic basalt in a trap rock quarry. The pseudomorphic alteration possibly occurred after burial of the lavas when, by ionic migration, Fe and Mg substituted for Ca, Na, and K.--D.O. Emerson.

2-2337. Foster, Margaret D. LAYER CHARGE RELATIONS IN THE DIOCTAHEDRAL AND TRIOCTAHEDRAL MICAS: Am. Mineralogist, v. 45, no. 3/4, p. 383-398, graph, 7 tables, March-Apr. 1960, 21 refs.

In theoretical formulas for dioctahedral and trioctahedral micas, the entire composite-layer charge originates in the tetrahedral layers owing to substitution of 1/4 of the Si by Al; the octahedral layer is neutral. But formulas calculated for published analyses of a great number of dioctahedral and trioctahedral micas show that these ideal charge relations are altered by the proxying of other cations for the octahedral cation theoretically present. Cations carrying a lower positive charge than the cation ideally presumed to occupy the octahedral sites, as Mg or Li for Al in dioctahedral micas, or Li for Mg or Fe^{+2} in trioctahedral micas, do not proxy for that cation in sufficient number to compensate for the difference in charge; consequently, not all the negative octahedral charges are neutralized, and the layer is left with a negative charge which necessitates an equivalent decrease in the tetrahedral negative charge by increase in Si and decrease in Al. In such micas, part of the total composite layer charge originates in the octahedral layer, part in the tetrahedral layer, and the total charge is the sum of 2 negative charges.

The additional charges carried by cations having a higher charge than the octahedral cations for which they proxy, as Al or Fe^{+3} for Mg in trioctahedral micas, may be accommodated in 2 ways: a) by a positive charge on the octahedral layer, which is compensated for by an equivalent increase in the negative tetrahedral charge by greater substitution of Al for Si, or b) by nonoccupancy of octahedral sites, the negative charges associated with these sites being then available to neutralize the additional positive charges carried by the proxying cations. Formulas of natural trioctahedral micas show that in most of them accommodation has been made in both ways to varying degrees; in very few has accommodation been made entirely in one way. In most trioctahedral micas, therefore, the total charge is made up of a positive octahedral charge and a negative tetrahedral charge greater than 1.00 by an equivalent amount.--Auth.

2-2338. Coombs, D.S. LAWSONITE METAGRAYWACKES IN NEW ZEALAND: Am. Mineralogist, v. 45, no. 3/4, p. 454-455, March-Apr. 1960, 5 refs.

Lawsonite is constantly present in a belt, over 2 mi. wide and 17 mi. long, of slates and volcanic graywackes of the Maitai group (Permian) in the Maitai Valley, Nelson, New Zealand. Tablets up to 0.1 mm. long occur in albitized plagioclase and in the matrix along with chlorite, quartz, calcite, and muscovite. To the S., this rock grades into a prehnite-pumpellyite metagraywacke facies.--D.O. Emerson.

2-2339. Markham, N.L. THE WILLEMITE-HEMIMORPHITE RELATIONSHIP: Econ. Geology, v. 55, no. 4, p. 844-847, diag., June-July 1960, 6 refs.

Discussion of a paper by D. Roy and F.A. Mumpton (Economic Geology, v. 51, p. 432-443, 1956). The hemimorphite-willemite dehydration curve is of interest in determining why one or another of these minerals forms. Considering the occurrence of willemite at depths ranging from near surface to 2,100 ft. in Abenab West, South West Africa, temperature alone is not likely a controlling factor. It is concluded that natural conditions favor a lowering of the dehydration curve temperatures. The transition between the 2 phases is sluggish, with ample scope for the retention of a metastable phase. Additional experimental work in the system $ZnO-SiO_2-H_2O$ at low temperatures is required.--J.A. Chamberlain.

2-2340. Gentile, A.L., and Rustum Roy. ISOMORPHISM AND CRYSTALLINE SOLUBILITY IN THE GARNET FAMILY: Am. Mineralogist, v. 45, no. 5/6, p. 701-711, 2 tables, May-June 1960, 9 refs.

Several dozen compositions have been reacted "dry" and under high water pressures in order to determine the extent, and explain the reason for, the solubility among the 3 garnet groups: ugrandite, pyralspite, and the rare earth garnets.

Ionic radius is shown to be the dominant variable, although a charge correction must be applied to the ions of different charges. At low pressure very little binary solubility is found between representatives of the pyralspite and ugrandite groups. However, complete crystalline miscibility exists between the rare earth garnets and each of the natural garnet groups. Moreover, $3CdO \cdot Al_2O_3 \cdot 3SiO_2$ also forms a garnet structure completely miscible with both spessartite and uvarovite. Very little Fe^{3+} was admitted into the $12CaO \cdot 7Al_2O_3$ garnet, and attempt at substitution of substantial amounts of OH^- and F^- in most garnets was unsuccessful.--Auth.

2-2341. Levinson, Alfred A., and R.A. Borup. HIGH HAFNIUM ZIRCON FROM NORWAY: Am. Mineralogist, v. 45, no. 5/6, p. 562-565, table, May-June 1960, 2 refs.

High Hf zircons from Iveland, Norway are described which have been found to contain 22 - 24% HfO_2. The ratio Hf/Zr is about 0.6. The zircons occurred protruding from a crystal of thortveitite (scandium silicate). The presence of Hf and Zr within the structure of thortveitite is confirmed.--Auth.

2-2342. Hutton, C. Osborne, and Angelina C. Vlisidis. PAPAGOITE, A NEW COPPER-BEARING MINERAL FROM AJO, ARIZONA: Am. Mineralogist, v. 45, no. 5/6, p. 599-611, 3 illus., diag., 4 tables, May-June 1960, 15 refs.

Papagoite, a rare hydrous copper calcium aluminum silicate, has been recognized, together with ajoite, as a strictly local occurrence, in metasomatically altered rocks at Ajo, Pima County, Arizona. The mineral forms more or less equidimensional crystals, less than 1 mm. in length, that are slightly flattened parallel to {001} with faces in the zone [010] well developed. The forms c{001}, g{401}, and m{110} are dominant in most cases, with d{102}, e{101}, f{201}, h{601}, and a{100} usually less prominent. Goniometric measurements lead to an axial ratio of 1.109:1:0.415, with $\beta = 100°30'$. A distinct cleavage parallel to (100) was noted in thin sections but it was not evident in crystals or fragments thereof. Papagoite is monoclinic prismatic, space group Cm, C2, or C2/m, with a=12.91 Å, b=11.48, c 4.69, all values ± 0.01 Å; $\beta = 100°38'$; a:b:c 1.124:1:0.408. A powder pattern is recorded and it has been indexed up to approximately $2\theta = 65°$; the d-spacings and intensities of the 5 strongest lines are: 2.874 Å (10), 4.29 (9), 2.204 (9), 2.795 (8), and 3.44 (8).

The mineral has a cerulean blue color in hand specimen and is distinctly pleochroic. Biaxial, negative; $\alpha = 1.607$, $\beta = 1.641$, $\gamma = 1.672$, $\gamma - \alpha = 0.065$; $2V = 78°$; dispersion faint, r>v; X=very pale glaucous green to colorless, Y=cendre blue, Z=Venice green; Z>Y>K; $X \wedge c = 44°$ or $X \wedge a = 35°$, both in the acute angle, and Z=b. Y is very nearly normal to the form f{201}. Specific gravity=3.25 (meas. and calc.).

A complete chemical analysis is reported, and dehydration and ammonia-exchange experiments indicate strongly that H is present as (OH) and not as

H_2O molecules. Calculation of cell contents indicates that a small amount of Si in the [Si-O] tetrahedra may be replaced by $[H_4]$, and accordingly the following formula is proposed for papagoite: $Ca_4(Cu, Mn, Fe)_{4.02}(Al, Mg, Ti)_4[Si(H_4)Al]_8O_{24}(OH)_{12.18}$. This may be simplified to: $4\{CaCuAl[SiO_3]_2(OH)_3\}$. The mineral has been named for the Indian tribe that once inhabited the region in which the mining center of Ajo, Arizona, is situated.--Auth.

2-2343. Foster, Margaret D. INTERPRETATION OF THE COMPOSITION OF TRIOCTAHEDRAL MICAS: U.S. Geol. Survey, Prof. Paper 354-B, p. 11-49, 7 diags., graph, 12 tables, 1960, 24 refs.

Structural formulas calculated for more than 200 published analyses of trioctahedral micas indicate that they form a complete ionic replacement system. From ideal phlogopite as the prototype, the composition of other trioctahedral micas may be derived by replacement of Mg by, most commonly, Fe^{+2} and R^{+3} (Al and Fe^{+3}). In phlogopites the proxying of such cations for Mg is minor, and Mg occupies more than 70% of the octahedral positions. Progressively greater proxying of these other cations, particularly Fe^{+2}, for Mg leads successively to Mg-dominant biotites, Fe^{+2} -dominant biotites, and finally siderophyllites and lepidomelanes, which contain little or no Mg.

Proxying of Fe^{+2} for Mg is ion for ion, and necessitates no adjustment in layer charge relations. Proxying for R^{+3} for Mg may be ion for ion, and accompanied by equivalent proxying of R^{+3} for Si, or may be in the ration of $2R^{+3}$ for $3R^{+2}$. In the first type of proxying the octahedral layer has a positive charge and the negative tetrahedral charge is greater than 1.00 by an amount equivalent to the positive octahedral charge; in the second type octahedral occupancy is less than 3.00. The positive octahedral charge, high tetrahedral charge, and deficient octahedral occupancy characterizing most of the formulas indicate that both types of proxying of R^{+3} for Mg is represented in them. Most of these micas are not truly trioctahedral, as fewer than 3.00 octahedral positions are occupied.

There is strong evidence against the existence of a complete series between phlogopite and muscovite. --Auth.

2-2344. Swineford, Ada, ed. CLAYS AND CLAY MINERALS. PROCEEDINGS OF THE SEVENTH NATIONAL CONFERENCE ON CLAYS AND CLAY MINERALS: 369 p., illus., maps, diags., graphs, tables, New York, Pergamon Press, 1960, refs.

The Seventh National Conference on Clays and Clay Minerals, sponsored by the Committee on Clay Minerals of the National Academy of Sciences-National Research Council, was held in Washington, D.C., October 20-23, 1958. The Proceedings stress regional clay mineralogy, the effect of saline water on clay minerals, genesis and identification of soil clays, and viscosity of clay suspensions. The 24 papers in the Proceedings are separately abstracted below in the order in which they appear in the volume.

2-2345. Whitehouse, U. Grant, Lela M. Jeffrey, and James D. Debbrecht. DIFFERENTIAL SETTLING TENDENCIES OF CLAY MINERALS IN SALINE WATERS (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 1-79, 21 figs. incl. illus., graphs, 27 tables, New York, Pergamon Press, 1960) 127 refs.

Differential settling velocities of individual clay mineral types and clay mineral mixtures in quiet saline water are reported for ocean water chlorinity range 0-18 $^0/_{00}$, brackish water ionic strength range 0.0-0.686 moles - (unit charge) ^{2}/kg., temperature range 6-26°C., clay mineral concentration range 0.01-3.6 g./l., and pH range 6.5-9.8. The materials employed included natural deposit clay minerals and clay minerals extracted from marine sedimentary matter and from terrestrial soils.

Settling velocities at 26°C. for illitic and kaolinitic materials reached values of 15.8 and 11.8 m./day, respectively, at an ocean water chlorinity of 18 $^0/_{00}$ and exhibited little dependence upon chlorinity above a chlorinity of 2 $^0/_{00}$. Settling velocities for montmorillonites were found to be functions of chlorinity over the entire chlorinity range 0-18 $^0/_{00}$ and to increase exponentially to a limit of 1.3 m./day at 26°C. The settling velocities were determined by pipette analysis, Oden balance techniques, Kelley-Wiegner manometer methods, and spectrophotometric methods, using artificial sea-water and filtered Gulf of Mexico water.

In quiet brackish water, variations in ionic ratio composition alter the settling rates of illites and kaolinites less than 15% from such rates in ocean water, at constant, brackish water, ionic strength of 14 or greater. In contrast, montmorillonitic settling rates in such water varied by 40% or more from ocean water rates, at constant ionic strength unless the Mg-K or Mg-Sr ionic ratios of the brackish water were kept constant. These induced variations were not sufficient in magnitude, however, to change the general relative order of settling rates for the clay minerals.

Decreasing temperatures over the range 26° - 6°C. decreased settling rates (of all clay types) progressively up to about 40% in accordance with temperature-induced changes in the viscosity and density of the saline water medium.

The influences of 57 different organic compounds or materials (carbohydrates and proteins dissolved or dispersed in the water) upon the settling velocities are cited. In general, carbohydrates increased the settling rates of montmorillonitic materials as much as 25%, and proteins decreased such rates a maximum of 1-5%. Kaolinitic materials suffered a 30-40% decrease in settling velocity under the influence of some proteins. So-called "humic acids," derived from quinone and soil fractions, decreased kaolinitic and montmorillonitic settling rates to lesser extent. No significant alterations of illitic settling rates by organic materials were noted.

Chlorite-montmorillonites were found to settle slightly faster than sodium and calcium montmorillonites. K-saturated montmorillonites settled from 2 to 3 times as rapidly as the reference montmorillonites. Chlorite settling rates, of magnitude comparable to rates found for kaolinites, and vermiculite settling rates, comparable at higher chlorinities to illite settling rates, are also reported.

The apparent interaction of illite and montmorillonite to form illitic-montmorillonitic settling entities in some clay mineral mixtures was noted. Other mixtures, exposed to artificial sea-water for 3-6 years, exhibited a tendency to transport 5-20% kaolinite within a developed illitic-chloritic mix, when reagitated.

Evidence is also presented to support the argument that clay minerals do not settle in single solid particulate units in saline waters. The effective settling unit, after flocculation, is described as a coacervate, i.e. as a thermodynamically reversible assembly of solid clay particles or strands within a settling solid-rich liquid unit phase. Settling rate increases are thereby not a consequence of any irreversible formation of larger solid particles or solid aggregates by coalescence of fresh water particles at or beyond the fresh-water - saline-water interface.

Differential transport of clay minerals by the turbulent flow of saline water in a pipe is quantitatively described. Flow rates of about 6 m.p.h. were required to eliminate differential transport of the clay minerals. Clay mineral concentrations over the range 0.01-15.0 g./l. were considered.

Chemical data, electron and X-ray diffraction data, base exchange data, and electron micrographs support the settling velocity information.--Auth.

2-2346. Carroll, Dorothy, and Harry C. Starkey. EFFECT OF SEA-WATER ON CLAY MINERALS (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 80-101, 5 diags., 2 graphs, 6 tables, New York, Pergamon Press, 1960) 27 refs.

Samples of a montmorillonite, a mixed-layer mineral (mica and montmorillonite), "illite," kaolinite, and halloysite were immersed in 50 ml. sea water for 10 days, and additional samples of the first 3 were immersed for 150 days. The exchangeable cations were determined both before and after treatment. It was found that Mg^{2+} ions from sea water moved into the exchange positions in the minerals in preference to Ca^{2+} and Na^{+} ions. The H-form of these minerals showed a gradual adjustment to sea water as measured by change in pH and filling of the exchange positions with cations other than H^{+}. Kaolinite adjusted very rapidly, but montmorillonite and the mixed-layer mineral were slow. All the minerals reacted to yield appreciable amounts of SiO_2, Al_2O_3, and Fe_2O_3 to the sea water. The quantities yielded are in the order: montmorillonite > mixed-layer mineral > "illite" > kaolinite > halloysite. The solubility is considered to be due to direct solution of SiO_2 in the sea water and to removal of Al_2O_3 from the octahedral layer of the minerals.

When H-clays were titrated with sea water 3 distinct kinds of curves were obtained: a) kaolinite; b) mixed-layer minerals, "illite," and halloysite; and c) montmorillonite. The curves are similar to those obtained with clay minerals titrated with other alkaline solutions. Kaolinite reacts somewhat like a number of simple acids, but the curves for the other minerals are more complex and are related to the neutralization of H^{+} and its replacement in the exchange sites by metallic cations. The exchangeable cations were determined in the minerals after titration, and the results are similar to those obtained after immersing the minerals in sea water. The volume of sea water required to reach an end point at about pH 7.6 varies from 11 ml. for kaolinite to 135 ml. for montmorillonite and is related to the titratable alkalinity of the sea water and to the exchange capacity of the minerals.--Auth.

2-2347. Hashimoto, Isao, and M. L. Jackson. RAPID DISSOLUTION OF ALLOPHANE AND KAOLINITE-HALLOYSITE AFTER DEHYDRATION (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 102-113, 6 figs. incl. diags., 5 tables, New York, Pergamon Press, 1960) 16 refs.

Differential dissolution in NaOH solution was investigated as a means of purification of clay. It was discovered that a large quantity of allophane and free alumina and silica were dissolved from clay preparations in 0.5 N NaOH solution by boiling for as little as 2.5 min., provided the ratio of clay weight to solution volume was kept less than 100 mg. to 100 ml. Reprecipitation of dissolved silica occurred if a more prolonged digestion or higher sample to solution ratio was employed. Also, prolonged digestion in the NaOH solution (for 80 min.) dissolved as much as 50% of kaolinite (Merck) and 25% of Wyoming montmorillonite, but only a small quantity of these crystalline minerals was dissolved during the 2.5 min. digestion period. Subsequent dithionite-citrate-bicarbonate treatment removed the released Fe. Marked improvement of X-ray diffraction patterns of the clays resulted. This rapid and selective dissolution of allophane and free oxides greatly improves the quantitative analysis of crystalline minerals by conventional methods.

After dehydroxylation at 500°C., kaolinite and halloysite became amorphous and also dissolved by the same differential dissolution procedure. Heat-stable (aluminous) montmorillonite and chlorite were only slightly dissolved by this treatment. The selective removal of the 1:1 layer aluminosilicates greatly improves the quantitative analysis of the remaining crystalline components of clays by conventional methods.--Auth.

2-2348. Slaughter, M., and Ivan H. Milne. THE FORMATION OF CHLORITE-LIKE STRUCTURES FROM MONTMORILLONITE (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 114-124, 10 figs., 2 tables, New York, Pergamon Press, 1960) 7 refs.

Chlorite-like complexes of montmorillonite with magnesium hydroxide or aluminum hydroxide have been prepared under a variety of physical and chemical conditions. Requirements for the preparation of these complexes have been simplified considerably by the use of rapid mixing techniques. A complex may be formed either by precipitating the hydroxide in a clay suspension or by preparing the precipitate separately and mixing it immediately with the clay suspension. It is suggested that the process involves the adsorption of a layer of the precipitate over the entire surface of the montmorillonite unit layer rather than the direct formation of a structure in the interlayer space. It is considered that there is no appreciable permanent association of unit 10 Å layers of montmorillonite in a well stirred suspension, even in the presence of strong salt solution, but that instead most clay surfaces are exposed continually. The chlorite-like structure develops only upon association of the unit layers through aging or dehydration.

The aluminum hydroxide complex with montmorillonite differs somewhat from the Mg type, but it has the approximate chlorite basal spacing. The complex shows a second-order basal diffraction spacing of low intensity, and forms regular expanded structures with water or ethylene glycol. A gibbsite structure for the interlayer material is most compatible with the X-ray data.

The occurrence of this process in sediments and soils is considered to be very probable, although it is premature to consider precise environments until more experimental data are available.--Auth.

2-2349. Kinter, Earl B., and Sidney Diamond. PRETREATMENT OF SOILS AND CLAYS FOR MEASUREMENT OF EXTERNAL SURFACE AREA BY GLYCEROL RETENTION (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 125-134, 2 tables, New York, Pergamon Press, 1960) 14 refs.

Heat treatment at 600°C. has been the usual procedure for irreversible collapse of expanding clay minerals prior to determination of the external surface area of clays and soils by glycerol retention. Evidence is presented showing that this treatment is unsuitable since it greatly reduces the external surface area of certain minerals and increases that of others. Saturation with the triethylammonium cation avoids these difficulties and produces an effect analogous to the collapse of expanding minerals by stabilizing their basal spacing at 13.3 Å. This prevents the entrance of glycerol between the unit layers and confines the sorption to the external surfaces of the particles.--Auth.

2-2350. Nelson, Bruce W. CLAY MINERALOGY OF THE BOTTOM SEDIMENTS, RAPPAHANNOCK RIVER, VIRGINIA (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 135-147, 9 figs., New York, Pergamon Press, 1960) 10 refs.

Bottom sediment clay mineral assemblages from the Rappahannock River and estuary contain kaolinite, illite, unorganized illite, dioctahedral vermiculite, 12.4 Å montmorillonite, 14.2 Å montmorillonite, chlorite, feldspar and quartz. The X-ray diffraction characteristics of these species and their thermal modifications at 25-500°C. are described and illustrated. Progressive changes in the mineralogical composition of bottom sediments occur between the fresh-water and saline-water portions of the Rappahannock system. Chlorite and feldspar occur exclusively in the saline portions of the estuary. Illite shows progressive increase in crystallization quality. There appears to be less kaolinite, proportionately, in the estuarine sediments of the most saline zone. X-ray diffraction diagrams showing these progressive changes are illustrated.--Auth.

2-2351. Heron, S. Duncan, Jr. CLAY MINERALS OF THE OUTCROPPING BASAL CRETACEOUS BEDS BETWEEN THE CAPE FEAR RIVER, NORTH CAROLINA, AND LYNCHES RIVER, SOUTH CAROLINA (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 148-161, map, 4 diags., New York, Pergamon Press, 1960) 26 refs.

The basal Cretaceous beds of the area are subdivided into 3 units: the Cape Fear formation, Middendorf formation, and Bladen member of the Black Creek formation. Stratigraphic position and lithology indicate that the Cape Fear is the oldest and the Middendorf is in part the landward facies of the Bladen. The Middendorf sediments are fluviatile and the Cape Fear and Bladen sediments are probably marine.

The Cape Fear and Bladen contain abundant montmorillonite, some kaolinite and lesser amounts of illite. In the Middendorf kaolinite predominates, although a few samples have small amounts of montmorillonite and illite.

Preliminary data indicate that in the Cretaceous-Tertiary sediments of the Atlantic Coastal Plain, montmorillonite occurs in abundance in the marine beds and kaolinite in the nonmarine sediments. The basal Cretaceous beds of the area studied fit into this scheme of clay mineral distribution.

The origin of the clay minerals of the Cretaceous formations studied is approached from sedimentary and empirical standpoints. The montmorillonite-marine and kaolinite-nonmarine associations strongly suggest that the montmorillonite has formed by marine diagenesis, whereas the sedimentary evidence suggests that the montmorillonite of the Cape Fear formation is detrital and the kaolinite of the Middendorf formation has formed by prolonged postdepositional weathering of a more varied clay mineral assemblage. The sediments of the Bladen unit in themselves offer little evidence as to the origin of their clay minerals. However, the predominance of kaolinite in the contemporary deltaic Bladen suggest that kaolinite was the only clay mineral supplied to the depositional area, and that in the marine part of the sedimentation area part of this kaolinite was changed to montmorillonite by marine diagenetic processes. --Auth.

2-2352. Pinsak, Arthur P., and Hayden H. Murray. REGIONAL CLAY MINERAL PATTERNS IN THE GULF OF MEXICO (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 162-177, 6 maps, graph, table, New York, Pergamon Press, 1960) 13 refs.

A semiquantitative study of the surficial clay mineral distribution from 79 cores in the Recent sediments in the Gulf of Mexico shows a regional pattern which can be related to source and environment. The dominant factor controlling distribution of these surficial sediments appears to be source. Montmorillonite is the most abundant clay mineral, and illite, chlorite, kaolinite and mixed-layer minerals are present in almost every sample.

Alteration of the clay minerals is influenced by a) change of environment, and b) length of exposure. Initial ion exchange, which is caused by a tendency to reach equilibrium with a new environment, occurs so rapidly in the clay minerals after they enter the marine environment that rate of sedimentation is a minor factor in comparison to environmental change. Slow alteration and adjustment toward a stable end state are most complete in areas of slow deposition and extended exposure of the clay minerals to the environment.--Auth.

2-2353. Patterson, Sam H., and John W. Hosterman. GEOLOGY OF THE CLAY DEPOSITS IN THE OLIVE HILL DISTRICT, KENTUCKY (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 178-194, 10 figs. incl. 6 illus., 2 maps, secs., table, New York, Pergamon Press, 1960) 18 refs.

The Olive Hill fire clay bed of Crider is the principal source of the raw material used in the refractory industry of eastern Kentucky. The bed is a discontinuous underclay from 1 to 20 ft. above a prominent unconformity which separates Mississippian and Pennsylvanian rocks. Upper Mississippian rocks consist of 10 marine limestone and shale units all truncated by the unconformity. Pennsylvanian rocks are chiefly: a) massive deltaic sandstone; b) cut-and-fill deposits of shale, siltstone, and sandstone which contain several beds of coal and underclay including the Olive Hill fire clay of Crider; and c) dark-gray shale beds.

The Olive Hill fire clay of Crider consists of approximately 1/3 flint clay, 2/3 semiflint clay, and minor amounts of plastic clay. The clay mineral content ranges from nearly pure kaolinite to kaolinitic clay containing about 40% illite and mixed-layer clay. The kaolinite ranges from highly crystalline to very poorly crystalline "fireclay" kaolinite. The degree of crystallinity of the kaolinite and hardness of the clay vary inversely with the amount of illite and mixed-layer clay present. The nearly pure kaolinite is believed to have formed by removal of silica and alkalies from mixtures of kaolinite, illite, and mixed-layer clay by leaching shortly after deposition.

An isopach map shows that Crider's Olive Hill fire clay occurs in irregular, lens-shaped deposits. Fossil plant rootstocks with rootlets attached in the clay clearly indicate it supported plant growth. The overlying coal and presence of some organic material in the clay suggest that the Olive Hill fire clay was deposited under a reducing environment in swamps.--Auth.

2-2354. Harrison, Jack L., and John B. Droste. CLAY PARTINGS IN GYPSUM DEPOSITS IN SOUTHWESTERN INDIANA (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 195-199, map, chart, New York, Pergamon Press, 1960) 4 refs.

Gypsum deposits of Mississippian age in southwestern Indiana contain several argillaceous partings. A study of these partings was made to find out what clay minerals are present in such an evaporite association.

The most abundant minerals in the clay partings are dolomite, gypsum, quartz, illite, chlorite, and mixed-layer illite-montmorillonite. No kaolinite was found in any of the samples.--Auth.

2-2355. Hensel, D.R., and Joe L. White. TIME FACTOR AND THE GENESIS OF SOILS ON EARLY WISCONSIN TILL (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 200-215, 2 maps, 7 diags., 3 tables, New York, Pergamon Press, 1960) 16 refs.

Radiocarbon dates indicate that the maximum time of weathering for soils of the Tazewell substage may be about 6,400 years longer than that available for weathering of soils of the Cary substage.

Detailed mineralogical and chemical studies were made of the $2\text{-}0.2\,\mu$ fractions of 0-6 in. and 30-36 in. samples from 24 sites along a traverse extending from the Cary substage across the Tazewell substage in E.-central Indiana. The major clay mineral constituents of the 0-6 in. samples were illite and 14 Å material; illite and montmorillonite were the main components in the 30-36 in. samples. The correlation coefficients between illite content and percentage K_2O for the 0-6 in. and 30-36 in. samples were 0.85 and 0.92, respectively.

The end and terminal moraines of the Tazewell substage were found to have a higher illite content than the ground moraines. This was attributed to superglacial movement and enrichment of foreign materials, i.e. mica schists from the Canadian shield, on end and terminal moraines.

The results of saturation of the clay fraction with K and Mg on the proportion of 10 Å, 12.7 Å, and 14 Å spacings indicated that weathering had lowered the surface charge density of the micaceous minerals in the 0-6 in. samples to a greater extent than in the 30-36 in. samples. This effect, in addition to other weathering reactions, resulted in partially expanded micaceous minerals in the 0-6 in. samples which were much more resistant to collapse than were the minerals in the 30-36 in. samples.

The rate of weathering of K_2O from the $2\text{-}0.2\,\mu$ fraction of the 0-6 in. samples located on ground moraines was estimated to be about 0.1% per 1,000 years. This value was used in estimating the ages of the morainic systems of the Tazewell in Indiana. The estimated ages were as follows: Mississinewa, (radiocarbon date) 13,140 years; Union City, 14,500 years; Bloomington, 15,500 years; Champaign, 18,700 years; Shelbyville, (radiocarbon date) 19,500 years.

The fertility status of the soils on the Tazewell has been influenced appreciably by the length of the weathering period, the K-supplying power of the soils decreasing with increasing age.--Auth.

2-2356. Schultz, Leonard G. QUANTITATIVE X-RAY DETERMINATIONS OF SOME ALUMINOUS CLAY MINERALS IN ROCKS (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 216-224, 2 figs., New York, Pergamon Press, 1960) 7 refs.

X-ray diffraction traces were made of oriented aggregates of artificial binary mixtures containing approximately equal, weighed amounts of samples of illite, montmorillonite, mixed-layered combinations of illite and montmorillonite, and of kaolinite samples having different degrees of crystallinity. Measurements most suitable for quantitative purposes were obtained from the 7 Å kaolinite peaks and from the 10 Å peaks of illite and collapsed montmorillonite and collapsed mixed-layer clay. In this paper the sum of 5 height measurements at half-degree intervals across the peak are considered to be a measure of the area of the peak. Fireclay-type kaolinites gave 7 Å peak areas about equal to the area of the 10 Å peak of an equal amount of illite, montmorillonite, or mixed-layer clay, whereas well-crystallized kaolinites gave 7 Å peak areas generally about twice that of the 10 Å peak of an equal weight of the illite-montmorillonite minerals. Kaolinite samples having intermediate degrees of crystallinity gave 7 Å/10 Å peak area ratios intermediate between 1:1 and 2:1. The shape of the 7 Å kaolinite peak was used to evaluate the crystallinity of the kaolinite.

X-ray diffraction characteristics of the chlorite minerals from the different groups of sedimentary rocks studied vary considerably, and no uniform method has been found for their evaluation.--Auth.

2-2357. Ross, Clarence S. REVIEW OF THE RELATIONSHIPS IN THE MONTMORILLONITE GROUP OF CLAY MINERALS (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 225-229, table, New York, Pergamon Press, 1960) 14 refs.

Since the publication of the paper on the minerals of the montmorillonite group by Ross and Hendricks some species have been added to the group, and minor changes in the acceptable species have become advisable. No radical changes are proposed, but a review of the members and their grouping is presented. The acceptable dioctahedral members of the group appear to be montmorillonite, nontronite, and volchonskoite. Beidellite should be discontinued. The acceptable trioctahedral members of the group appear to include saponite, hectorite, sauconite, stevensite, and medmontite. Griffithite is probably a useful term for a Fe-rich saponite. Representative chemical analyses and formulas have been assembled to illustrate relationships.--Auth.

2-2358. Parrish, William. ADVANCES IN X-RAY DIFFRACTOMETRY OF CLAY MINERALS (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 230-259, 18 figs. incl. illus., diags., graphs, 3 tables, New York, Pergamon Press, 1960) 49 refs.

The introduction of counter tubes and the related instrument geometries have made it possible to obtain greatly improved X-ray powder patterns. Most of the important factors that must be understood in X-ray diffractometry are described in terms of their effect on the intensity, peak-to-background ratio, resolution, and line shape. These factors are the geometry of the X-ray optical system, the X-ray tube focal spot size, the angular apertures of the primary beam in the focusing and axial planes, the 2:1 setting, and the receiving slit. The precision is often limited by the specimen preparation rather than the instrument, and the effects of homogeneity, displacement and transparency, crystallite sizes, and preferred orientation are outlined. A new diffractometer arrangement employing a transmission specimen followed by a focusing crystal monochromator is shown to be a useful supplement to the standard reflecting specimen diffractometer for clay mineral studies. The important characteristics of Geiger, proportional and scintillation counters are described in terms of linearity, quantum counting efficiency, pulse amplitude distribution and counting statistics. A bibliography of key literature references is appended.--Auth.

2-2359. Bradley, W.F., and J.M. Serratosa. A DISCUSSION OF THE WATER CONTENT OF VERMICULITE (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 260-270, 7 figs., table, New York, Pergamon Press, 1960) 9 refs.

Selected chemical and diffraction analyses from the literature, supplemented by thermal and thermogravimetric analyses and infrared absorption observations, are utilized to construct a rational model of the water arrangement in natural vermiculites.

A super cell is arranged by simple modification of the Hendricks water nets to accommodate the somewhat higher water contents, indicated by weight loss analyses, and the exchangeable cations.

A 3-cell unit (15.6 x 9 Å) contains two $Mg^{2+} \cdot 6H_2O$ octahedra centered at the corners and face centers and four $4H_2O$ squares centered about ± 5.2Å along a between the octahedra. The arrangement affords 20 H bonds near 2.75 Å, 12 between silicate and water layers and 8 between water layers, and 32 H bonds near 3.0 Å within water layers. The remaining 4 hydrogens are not active in the bonding system. The environment of each water molecule is a distorted tetrahedron.

A broad infrared absorption band shows maxima at about 3,600, 3,450 and 3,350 $cm.^{-1}$ at normal incidence, with increased activity in the highest and lowest energies when a flake is tilted. It is concluded that OH axes in the shortest bonds are more inclined to the cleavage planes than are the intermediate length axes.--Auth.

2-2360. Groot, Johan J., and Herbert D. Glass. SOME ASPECTS OF THE MINERALOGY OF THE NORTHERN ATLANTIC COASTAL PLAIN (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 271-284, 2 tables, New York, Pergamon Press, 1960) 13 refs.

Studies of the mineralogy of the northern part of the Atlantic Coastal Plain indicate that the heavy mineral content of the Cretaceous and Cenozoic sediments consists basically of 2 suites, a restricted mineral suite characterized by very stable minerals, and a full suite consisting of a great variety of igneous and metamorphic minerals. The restricted suite occurs in the nonmarine sediments and the full suite in the marine deposits.

The nonmarine Cretaceous deposits consist of kaolinite, with variable amounts of illite and its alteration products. Transition sediments like those of the Magothy formation contain kaolinite, illite, chloritic material and, occasionally, some montmorillonite. Thus, a limited heavy mineral suite and kaolinite are associated in nonmarine deposits, and a full suite and montmorillonite are found in marine sediments.

On the basis of available data the conclusion is reached that the different heavy mineral and clay mineral suites are a result of different source areas for the marine and nonmarine sediments.

The suggestion is made that the formational concept cannot be employed with regard to the nonmarine sediments of the northern Coastal Plain but that, instead, a new concept be adopted based on depositional conditions within the framework of the control of the heavy and clay mineral assemblages.--Auth.

2-2361. Hosterman, John W. GEOLOGY OF THE CLAY DEPOSITS IN PARTS OF WASHINGTON AND IDAHO (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 285-292, 6 figs. incl. 3 illus., map, table, New York, Pergamon Press, 1960) 6 refs.

The clay deposits of eastern Washington and northern Idaho are along the eastern edge of the Columbia River Plateau physiographic province. Three types of clay occur in the area: a) residual clay derived from the Columbia River basalt of Tertiary age; b) residual clay derived from the Cretaceous granodiorite and related intrusive rocks of the Idaho batholith; and c) transported clay. The 2 types of residual clay were formed during a protracted lull in the outpouring of the Columbia River basalt, when the relief of land surface was low to moderate and the climate was warm and humid. The topography and climate during this interval were probably ideal for leaching and oxidation. The transported clay is chiefly a product of the weathered granodiorite and related intrusive rocks. Most of it accumulated in basins formed by damming of streams by basalt flows.

Kaolinite and halloysite are the principal clay minerals found in the area. The residual clay derived from basalt is chiefly composed of halloysite. Most of this clay is colored blue, gray, or grayish black by finely disseminated ilmenite and locally it is stained brown by limonite; most of it has a relict basaltic texture.

The residual clay derived from granodiorite and related intrusive rocks contains both kaolinite and halloysite, and the transported clay is predominantly kaolinite. Both of these clays are white and contain abundant quartz grains and mica flakes. The residual clay has a relict granitic texture, and the transported clay has a well-developed bedding and is interbedded with clastic material.--Auth.

2-2362. Keller, Walter D. CLAY MINERALS IN THE MORRISON FORMATION ON THE COLORADO PLATEAU (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 293-294, New York, Pergamon Press, 1960)

An extended abstract is all that is given of the paper prepared for publication by the U.S. Geological Survey.

2-2363. Stubičan, V. CLAY MINERAL RESEARCH AT THE INSTITUTE FOR SILICATE CHEMISTRY, ZAGREB (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 295-302, 10 figs. incl. illus., diags., New York, Pergamon Press, 1960) 13 refs.

Part of the research on the structure, synthesis, and properties of clay minerals in Yugoslavia is reviewed with particular reference to the following problems: a) attempts to synthesize halloysite from solutions under normal conditions; b) structure and properties of synthetic montmorillonites; c) dehydroxylation of kaolin minerals under nonequilibrium conditions; d) structural properties of metakaolin as shown by adsorption of colloidal Au; and e) free silica in bentonites.--Auth.

2-2364. Warshaw, Charlotte M. EXPERIMENTAL STUDIES OF ILLITE (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 303-316, 3 figs., 5 tables, New York, Pergamon Press, 1960) 16 refs.

Investigations in the system K_2O-MgO-Al_2O_3-SiO_2-H_2O were made in an attempt to synthesize micas similar to illite and to determine their upper stability limits. These are representative of materials referred to by many clay mineralogists as illite, hydromuscovite and K-bentonite. Gels of these compositions were treated hydrothermally at temperatures above 250°C. and at pressures above 10,000 lb./in.^{2}. Natural illites and related minerals were also treated under the same conditions.

It is possible to prepare phases having the properties of illite. This is achieved below 500°C. but above this temperature well-crystallized micas plus other phases are obtained. The partially disordered micas formed from K-deficient compositions give the X-ray diffraction pattern of the 3T polytype, whereas the well-crystallized micas obtained with more K_2O or at higher temperatures are the 1M polytype. Once formed at lower temperatures, however, the 3T mica is persistent and not readily transformed at higher temperatures. The 2M polytype, which is reported to be the stable form for pure muscovite at the temperatures of this investigation, was not obtained.

Compositions with the same alumina:silica ratio as muscovite but with less K do not yield a mica-type mineral as a single phase under the conditions of these experiments. However, those in which the lower K content is compensated by less substitution and lower layer charge do yield illite alone. These studies indicate that the differences in properties between illites and well-crystallized micas are a function of composition as well as of the temperature of formation.--Auth.

2-2365. Mehra, O.P., and M.L. Jackson. IRON OXIDE REMOVAL FROM SOILS AND CLAYS BY A DITHIONITE-CITRATE SYSTEM BUFFERED WITH SODIUM BICARBONATE (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 317-327, diag., 6 tables, New York, Pergamon Press, 1960) 16 refs.

The oxidation potential of dithionite ($Na_2S_2O_4$) increases from 0.37 V to 0.73 V with increase in pH from 6 to 9, because hydroxyl is consumed during oxidation of dithionite. At the same time the amount of iron oxide dissolved in 15 min. falls off (from 100% to less than 1% extracted) with increase in pH from 6 to 12 owing to solubility product relationships of iron oxides. An optimum pH for maximum reaction kinetics occurs at approximately pH 7.3. A buffer is needed to hold the pH at the optimum level because 4 moles of OH are used up in reaction with each mole of $Na_2S_2O_4$ oxidized. Tests show that $NaHCO_3$ effectively serves as a buffer in this application. Crystalline hematite dissolved in amounts of several hundred milligrams in 2 min. Crystalline goethite dissolved more slowly, but dissolved during the two or three 15 min. treatments normally given for iron oxide removal from soils and clays.

A series of methods for the extraction of iron oxides from soils and clays was tested with soils high in free iron oxides and with nontronite and other Fe-bearing clays. It was found that the bicarbonate-buffered $Na_2S_2O_4$-citrate system was the most effective in removal of free iron oxides from latosolic soils, and the least destructive of iron silicate clays as indicated by least loss in cation exchange capacity after the iron oxide removal treatment. With soils the decrease was very little but with the very susceptible Woody district nontronite, the decrease was about 17% as contrasted to 35-80% with other methods. --Auth.

2-2366. Nash, V.E. ROLE OF EXCHANGEABLE CATIONS IN VISCOSITY OF CLAY SUSPENSIONS (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 328-342, 12 diags., New York, Pergamon Press, 1960) 6 refs.

A study was made of the changes in viscosity of Wyoming bentonite suspensions with variations in cation ionization, base saturation, clay concentration, sodium chloride concentration, and type of exchangeable cation. There is little change in the viscosity with decreasing cation ionization until a certain threshold value is reached. Below this value the viscosity increases rapidly, indicating that the repulsive potential barrier has been reduced to the order of the kinetic energy of the particles. Unfortunately, a quantitative estimate of the ionization was not possible at this value because of the high salt content of the system.

Exchangeable Al was found to act as a strong bonding agent between clay particles in the pH range 4.50-5.50. This was explained on the basis of the formation of multivalent, aluminum-hydroxyl complex ions. --Auth.

2-2367. Warkentin, B.P., and R.K. Schofield. SWELLING PRESSURES OF DILUTE Na-MONTMORILLONITE PASTES (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 343-349, 2 figs., 2 tables, New York, Pergamon Press, 1960) 8 refs.

Swelling pressures calculated from diffuse double-layer theory previously had been experimentally verified for Na-montmorillonite at clay concentrations above 10%, but published data at clay concentrations less than 5% consistently showed osmotic pressures much lower than the maximum of about 40 cm. water calculated from theory. Swelling pressures of Na-montmorillonite in 4-5% orientated suspensions were therefore measured in a specially constructed osmometer in various solutions of NaCl up to 1.25 mN. The osmometer construction allowed solutions of desired concentration to be flushed continually across the membrane separating solution from clay. It was found that soluble impurities present in the clay decreased swelling pressures to about 1 cm. of water. When these were removed during sample preparation, most efficiently by ultrafiltration through a dialysis membrane, swelling pressures measured were in satisfactory agreement with calculated values. The impurities were not identified chemically, but buffer curves of the solution toward HCl were determined.--Auth.

Discussion by H. van Olphen and reply by the authors follow the paper.

2-2368. Barshad, Isaac. X-RAY ANALYSIS OF SOIL COLLOIDS BY A MODIFIED SALTED PASTE METHOD (In: Swineford, Ada, ed. Clays and Clay Minerals...: p. 350-364, 5 tables, New York, Pergamon Press, 1960) 13 refs.

Glycerol-ethanol sodium salted clay pastes prepared from clays extracted directly from the soils and not allowed to dry were found to yield superior X-ray diffraction diagrams for the identification of the major clay minerals than pastes prepared from clays that suffered dehydration after extraction.

Prevention of drying of soil clays after their extraction from the soils is essential for proper identification of the clay minerals. This is particularly true for identification of hydrated halloysite and for differentiation between high exchange forms and low exchange forms of montmorillonite. This differentiation is based on the finding that glycerol-ethanol salted K-saturated montmorillonite pastes prepared from clay suspensions have a 001 spacing of 18.5 Å whenever the exchange capacity ranges between 92 and 95 meq./100 g. oven-dry clay, and 14.5 Å whenever the exchange capacity ranges between 115 and 135 meq./100 g. Either both these spacings or a mixed-layer spacing appears in montmorillonites having exchange capacities between 95 and 115 meq./100 g.

Saturation of pure vermiculite minerals brings about contraction in the 001 spacing from 14.2Å to 10.6Å only after air drying in those forms with exchange capacities ranging between 200 and 207 meq./100 g. water-free mineral, but in vermiculites with an exchange capacity of 250 meq./100 g. this contraction occurs even without drying. Both of these forms of vermiculite are found in soils.

Several sets of "standardized" natural clay mineral mixtures are necessary for quantitative X-ray analysis of soil clays.--Auth.

2-2369. Grim, Ralph E. SOME APPLICATIONS OF CLAY MINERALOGY: Am. Mineralogist, v. 45, no. 3/4, p. 259-269, March-Apr. 1960, 18 refs.

"Clay materials are the essential components of most soils and therefore, are of great importance in agriculture. The engineer is frequently required to build a structure on, through, or with soil materials. Clays are used as raw materials in many manufactured products, for example, ceramic products, paper, paint, and catalysts. The properties of clay materials are determined largely by their clay mineral composition, or more fundamentally by the structure, composition, and physical attributes of the clay minerals. It follows, therefore, that knowledge of the structure, composition, and properties of the clay minerals has great practical value."

"This matter of applying knowledge of the clay minerals to practical problems involving the use of clays and soils" is called "applied clay mineralogy" by the author. A few examples of the application of clay mineral data are presented.--From introd.

2-2370. Brown, Charles Q. CLAY MINERAL RELATIONS IN TWO TRIBUTARY BASINS WITHIN THE YORK RIVER TRIBUTARY BASIN: Southeastern Geology, v. 1, no. 3, p. 95-104, 3 maps, 2 tables, Autumn 1959, 6 refs.

Clay mineralogy of source materials and stream sediments of a Piedmont and a Coastal Plain tributary basin are compared. They are similar. Kaolinite, vermiculite, illite, montmorillonite, and mixed-layer clay minerals are found in the course area and stream sediments of both basins. An atypical vermiculite, common to source and sediment materials, is recognized. Expandable illite is restricted to Piedmont soils. Provenance largely determines the qualitative clay mineralogy of stream sediments in a small drainage basin. Clay mineralogy of the sediments is not, however, a perfect reflection of provenance, the near absence of mixed-layer clay minerals in stream sediments being a major difference. Average intensities of basal reflections of stream clays are less than that of the materials serving as the source material. --Auth.

2-2371. Heinrich, E. Wm., and M.A. Conrad. DETRITAL EUXENITE AND ASSOCIATED MINERALS, SAND BASIN, GRANITE COUNTY, MONTANA: Am. Mineralogist, v. 45, no. 3/4, p. 459-464, illus., 3 tables, March-Apr. 1960, 9 refs.

Monazite, sphene, euxenite, allanite, zircon, and thorianite are found with other heavy minerals in layers and lenses within coarse stream sands of Sand Basin, Montana. This "radioactive blacks" deposit is similar to the Idaho occurrences and has a nonpegmatitic derivation from the accessory minerals of an Idaho batholith granodiorite. The varied assemblage of U-Th-Nb-Ta bearing accessories in the igneous rocks and derived placers of the Idaho batholith may serve to distinguish them from those of the Boulder batholith.--D.O. Emerson.

2-2372. Seki, Yôtarô, Mizuo Aiba, and Chigusa Kato. JADEITE AND ASSOCIATED MINERALS OF METAGABBROIC ROCKS IN THE SIBUKAWA DISTRICT, CENTRAL JAPAN: Am. Mineralogist, v. 45, no. 5/6, p. 668-679, 2 illus., 2 maps, 7 tables, May-June 1960, 12 refs.

Jadeite was found in metagabbroic rocks of the Sanbagawa metamorphic terrain in the Sibukawa district, central Japan. Veins chiefly composed of jadeite were also found in the metagabbro. Metamorphic minerals associated with the jadeite are lawsonite, pumpellyite, chlorite, vesuvianite, and grossularite. Besides these minerals, small amounts of quartz, sodic plagioclase, analcite, and calcite were found, but it is not clear whether these minerals are in stable association with the jadeite.

The chemical, optical, and X-ray data of jadeite and some associated minerals are given. The jadeite was formed probably under high water pressure at low temperature during the Sanbagawa metamorphism. The desilication of its host-rock by the associated ultramafic rock may have promoted its formation.--Auth.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Structural Geology 2-2233; Fuels 2-2431.

2-2373. Bayly, M.B. ERRORS IN POINT-COUNTER ANALYSIS: Am. Mineralogist, v. 45, no. 3/4, p. 447-449, March-Apr. 1960, 9 refs.

By altering point spacing and using counts of equal length, the area sampled and rock coarseness can be combined into a single factor. Thus, using Chayes' notation, $V_{\underline{p}} = V_{\underline{c}\text{(ounting)}} + V_{\underline{s}\text{(ampling)}} = f(\text{count length}) + f(\text{A(rea)} \cdot \text{IC number}^2)$. From Chayes' data, V_c may be equated to $\underline{p}(1-\underline{p})/\underline{n}$, ($\underline{p}$=proportion of mineral in rock; $\underline{n}$=count length) and $V_{\underline{s}} = \underline{k} \cdot (A \cdot IC^2)^{-1}$ where, for A in mm.^{2}, $\underline{k} = 4.58 \times 10^6$.--D.O. Emerson.

2-2374. Stevens, Rollin E., and others. SECOND REPORT ON A COOPERATIVE INVESTIGATION OF THE COMPOSITION OF TWO SILICATE ROCKS: U.S. Geol. Survey, Bull. 1113, 126 p., 8 figs., 21 tables, 1960, 94 refs.

Following an introduction by Michael Fleischer, the bulletin is divided into 5 parts, each of which is abstracted separately below in the order in which it appears in the book.

2-2375. Stevens, Rollin E., and William W. Niles. CHEMICAL ANALYSES OF THE GRANITE AND THE DIABASE, Pt. 1 (In: Stevens, Rollin E., and others. Second Report on a Cooperative Investigation of the Composition of Two Silicate Rocks: U.S. Geol. Survey, Bull. 1113, p. 3-43, 6 figs., 8 tables, 1960)

Results are compiled of more than 30 partial and complete new analyses of G-1 and W-1 from laboratories throughout the world. The new analyses are compared with each other and with previous analyses published in U.S. Geological Survey Bulletin 980. Conventional methods of rock analysis are examined for sources of error to account for the wide divergence of results. Although the range of results for each constituent is large, arithmetic means and medians of all and of preferred values, for both the new and the old analyses, show general agreement with published results by competent analysts and with results by methods other than conventional. Further evidence is given that low results for SiO_2 are obtained in most laboratories with techniques and procedures in present use. There is lack of precision and apparent positive bias in results for Al_2O_3 and Fe_2O_3. Results for K_2O tend to be low. Results for other constituents are in better agreement and seem to be more reliable. The need for improvement in the field of rock analysis is again shown.--Auth.

2-2376. Stevens, Rollin E., and Arthur A. Chodos. SPECIAL STUDY OF THE SILICA CONTENT OF G-1 AND W-1 BY COMBINED WET CHEMICAL AND SPECTROGRAPHIC METHODS, Pt. 2 (In: Stevens, Rollin E., and others. Second Report on a Cooperative Investigation of the Composition of Two Silicate Rocks: U.S. Geol. Survey, Bull. 1113, p. 45-56, 2 tables, 1960)

Values of 72.70 and 52.77% SiO_2 for G-1 and W-1 (moisture free), respectively, were obtained by collecting and weighing the silica and by determining spectrographically and with wet chemical methods the corrections that were needed, owing to impurities in the separated silica, losses of silica in the chemical processes, and gains of silica from reagents and filter paper. Possible errors in the determinations were thus measured and tallied. These results are .2-.3% higher than the consensus mean of analyses made in the usual way and add to the evidence that complete recovery of silica is not usually attained in routine analytical procedures for silica in general use.--Auth.

2-2377. Filby, Royston H., and R.K. Leininger. SPECTROGRAPHIC DETERMINATIONS OF THE MAJOR CONSTITUENTS OF GRANITE G-1 AND DIABASE W-1, Pt. 3 (In: Stevens, Rollin E., and others. Second Report on a Cooperative Investigation of the Composition of Two Silicate Rocks: U.S. Geol. Survey, Bull. 1113, p. 57-82, 8 tables, 1960)

The advantages of spectrochemical methods of silicate analysis include rapidity, reasonable precision, use of small sample, and determination of several elements in one operation. Although systematic errors exist, such as those due to matrix and self-absorption effects and those caused by use of synthetic or otherwise known standard samples, the methods can provide determinations that are adequately accurate for many purposes.

All available spectrographic determinations of the major constituents of G-1 and W-1 were studied to permit a comparison of the precision of analytical chemical and spectrographic methods. Examination of the spectrographic methods used by contributors shows frequent use of the direct-current arc with an air jet, and a sample buffered with Li_2CO_3 or $SrCO_3$. The comparison of results for precision reveals that spectrographic methods are as precise (and therefore probably as accurate) as chemical methods for several constituents. Fairbairn's correction for the bias in the chemical results for SiO_2 and Al_2O_3 is concluded to be too large in magnitude for SiO_2 and Al_2O_3 in G-1 and for Al_2O_3 in W-1.

A table of recommended values for the major constituents of the 2 reference samples may be summarized as follows (in the order, G-1, W-1): SiO_2, 72.65, 52.64; Al_2O_3, 14.23, 15.00; total iron as Fe_2O_3, 1.96, 11.13; MgO, 0.39, 6.61; CaO, 1.36, 10.94; Na_2O, 3.32, 2.07; K_2O, 5.43, 0.64; TiO_2, 0.24, 1.08; MnO, 0.027, 0.18. The Al_2O_3, CaO, MgO, and K_2O values were corrected for tace elements which interfere with normal chemical determinations, for example, K_2O has been corrected for Rb_2O.

Examination of the available spectrometric determinations shows the high precision and accuracy that may be obtained by the use of synthetic standards and direct-reading methods.--Auth.

2-2378. Ahrens, L.H., and Michael Fleischer. REPORT ON TRACE CONSTITUENTS IN GRANITE G-1 AND DIABASE W-1, Pt. 4 (In: Stevens, Rollin E., and others. Second Report on a Cooperative Investigation of the Composition of Two Silicate Rocks: U.S. Geol. Survey, Bull. 1113, p. 83-111, graph, 1960)

Data on trace constituents of the rocks G-1 and W-1 given in U.S. Geological Survey Bulletin 980 consisted mainly of spectrographic analyses by 3 laboratories. Since then the rocks have been studied by many laboratories and by chemical-colorimetric, isotope-dilution, and neutron-activation methods as well as by the spectrographic procedures. All available data have been assembled in this paper. It is now possible to give preferred values, many of which seem to be well established, for many elements.--Auth.

2-2379. Flanagan, Francis J. THE LEAD CONTENT OF G-1, Pt. 5 (In: Stevens, Rollin E., and others. Second Report on a Cooperative Investigation of the Composition of Two Silicate Rocks: U.S. Geol. Survey, Bull. 1113, p. 113-121, diag., 3 tables, 1960)

In 1954 the lead content of rock sample G-1 was thought to be 27 p.p.m., but results differing considerably from this were reported by several laboratories. To test the validity of the recommended value of 27 p.p.m., a cooperative investigation of the Pb content of sample G-1 was undertaken by 6 laboratories, using 6 bottles, prepared in 1951, which had never been opened, and a sampling that insured equal treatment of all analysts.

Using the analysis of variance, it was shown that laboratories yield results significantly different. When the data were classified by sampling order, the variation was also significant but the data contained no recognizable trends that might indicate the cause of the difference. There was, however, no significant difference between the 6 samples. The best estimates at present of the Pb content are grand average, 49 p.p.m.; spectrographic average, 50 p.p.m.; and chemical average, 47 p.p.m.--Auth.

2-2380. Kuellmer, Frederick J. COMPOSITIONAL VARIATION OF ALKALI FELDSPARS IN SOME INTRUSIVE ROCKS NEAR GLOBE-MIAMI, ARIZONA: Econ. Geology, v. 55, no. 3, p. 557-562, map, graph, table, May 1960, 12 refs.

Approximate compositional determinations were made by means of X-ray study of the $(\bar{2}01)$ spacings of heated alkali feldspars. Of 32 alkali feldspar specimens from the Lost Gulch quartz monzonite [early Mesozoic(?)], 17 from within the areas of moderate hydrothermal alteration average 93 weight per cent orthoclase (Or/Or+Ab+An), whereas the remaining specimens, from outside the moderately altered areas, contain only 83 weight per cent orthoclase. Likewise, alkali feldspar specimens (7) from within the moderately altered area near the Inspiration lobe of the Schultze granite [Tertiary(?)] have an average bulk composition of Or_{85}, and Schultze granite and Inspiration lobe feldspar specimens (21) from outside the area of moderate alteration have an average bulk composition of only Or_{78}. Primary magmatic crystallization differentiation, or hydrothermal crystallization or recrystallization appears to be a plausible hypothesis to explain these compositional differences. Such compositional variations suggest again a genetic relationship between magmatic crystallization and ore concentration.--Auth.

10. SEDIMENTARY PETROLOGY

See also: Areal and Regional Geology 2-2215; Geomorphology 2-2224; Mineralogy 2-2345, 2-2350 through 2-2353, 2-2360, 2-2361, 2-2370.

2-2381. Walker, Kenneth R. A STUDY OF THE DISPERSAL OF A CALCAREOUS SEDIMENT: Southeastern Geology, v. 1, no. 4, p. 139-145, 3 diags., tables, Apr. 1960, 9 refs.

A number of samples of a calcareous shale were treated with a standard procedure, but varying reagents and reagent normalities, with the object of dispersing the sediment without dissolving the calcium carbonate content. The stability of the resultant dispersals was tested by determing the degree of dispersal after successive 48 hour periods. The best and most stable dispersal was achieved with 0.300 N sodium hexametaphosphate. The conclusions of this study are not necessarily applicable to all calcareous sediments because only one shale was studied.--Auth.

2-2382. Phelps, G.W. PRACTICAL GRAIN SIZE ANALYSIS OF CLAYS: III, LOG PROBABILITY DATA PLOTTING: Am. Ceramic Soc., Bull., v. 39, no. 5, p. 267-269, 3 diags., 2 tables, May 1960, 6 refs.

Grain size analysis of clays may be simplified by using log probability plotting. Applied to kaolin-rich clays, the method works well for grain sizes 10.0-0.2 microns. The method tends to break down in coarser or finer sizes; it is suggested that this is due to the coexistence of 2 or more skewed distributions of grain size.--F.P. Glasser.

2-2383. Beales, F.W. LIMESTONE PEELS: Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 4, p. 132-135, 4 illus., Apr. 1960, ref.

Carbonate rock studies at times demand a more thorough investigation than is permitted by conventional binocular microscope and thin section examination. The preparation of acetate peels is a quick, simple, inexpensive adjunct to such studies that has the advantage of being equally available to field, wellsite, and laboratory geologists.--Auth.

11. GEOHYDROLOGY

See also: Mineral Deposits 2-2410; Fuels 2-2427; Engineering Geology 2-2451.

2-2384. Salzman, Michael H. NEW WATER FOR A THIRSTY WORLD: 210 p., Los Angeles, California, Science Foundation Press, 1960, 198 refs.

This book has its basis in a "demonstrated discovery by Stephan Riess that fresh, potable water flowing in deep-seated solid rock fissures could be scientifically located from the surface of the earth, and economically intercepted by drilling through the hard, impermeable rocks so as to constitute an abundant water supply which heretofore has been virtually neglected." More and more evidence, already in the literature but scattered throughout many fields, has been found to support his basic concept. "This economical water supply, independent of local rates of precipitation, could help solve the water shortage problems confronting the world."

The question of the origin of these waters gets deep into the theories of the genesis of all the waters on the earth's surface. "A tremendous body of geologic and other evidence supports the theory that the waters on the surface of the earth have come from within the interior of the earth throughout geologic time and that this process continues today."--From pref.

The introduction covers the continuing struggle for water, population growth, population shift in the United States, industrial growth in the United States, periodic droughts, pollution of streams and lakes, salt water encroachment, radioactive contamination, mining, mine waters, and fresh, potable water.

Chap. 2, What is Water?, discusses matter and environment, water fundamentals, photosynthesis, water lost by photochemical dissociation, etc., unavailable waters, water - the mineral, hydrogen, oxygen.

Chap. 3, New Water, is concerned with natural occurrence, accidental occurrence, predictive occurrence. Also included is a paper by A.E. Nordenskiöld, "About Drilling for Water in Primary Rocks."

Chap. 4, The Modern Science of Hydrology and its Limitations, deals with saline water conversion, cloud seeding, reclamation of used water, the reduction of evaporation, the hydrologic cycle, limitations of the science of hydrology, unconscious delimiting, conscious delimiting, geologist v. hydrologist, hydraulics.

Chaps. 5 and 6, The Dynamic Earth, cover origin of the earth's hydrosphere, rock systems, alteration, and earth tides, igneous rocks and magmatic water, metamorphic rocks and metamorphic water, volcanic activity and volcanic water, stages of magmatic crystallization, hydrothermal deposition, hot springs, geologic thermometers, laboratory experiments, isotope geology, piezoelectricity, etc.

Chap. 7, Man's Challenge, discusses science and operationalism, deserts, afforestation, municipal water supplies and public health.

2-2385. Jones, John F. GROUNDWATER GEOLOGY, BEAVERLODGE DISTRICT: Research Council Alberta, Geol. Div., Prelim. Rept. 59-2, 32 p., illus., 1959, 13 refs.

Approximately 85% of the water supply in the Beaverlodge district, Alberta, is obtained from wells in sandstones of the Wapiti formation [Upper Cretaceous]. The remaining 15% is obtained from wells in Cenozoic sands and gravels. A "buried channel" which contains water-bearing sands and gravels was outlined from geologic and seismic surveys and by test drilling. An average transmissibility of 4,200 gallons per day-foot was determined by pumping tests. Wells of capacities up to 60 gallons per minute might be obtained from the buried gravels with additional exploration. The recharge, movement, and discharge of ground water appear to be controlled by local topography. The water in the bedrock is generally softer than that found in the overlying surficial deposits.

The Beaverlodge district is one of the few known areas in the Peace River region where, at the present time, an adequate supply of potable water can be obtained from water wells for most municipal and domestic use. The successful delineation by geological and geophysical means of a buried channel containing water-bearing sands and gravels in the district adds to the hope that similar conditions will be found elsewhere in the Peace River region where ground water is difficult to obtain from wells.--Auth.

2-2386. Scott, John C. GROUND-WATER RESOURCES OF MACON COUNTY, ALABAMA, A RECONNAISSANCE REPORT: Alabama, Geol. Survey, Inf. Ser. 16, 97 p., 4 pls. (in pocket) incl. map, 3 secs., 10 figs. incl. 5 maps, diags., graph, 5 tables, 1960, 16 refs.

Macon County, in E.-central Alabama, is in the N. part of the Coastal Plain and is bounded by Elmore, Tallapoosa, Lee, Russell, Bullock, and Montgomery counties. It has an area of 614 sq. mi. and in 1950 had a population of 30,560.

The county is divided topographically into the Piedmont and the Coastal Plain. There are parts of 4 divisions of the Coastal Plain in the county: the central Pine belt, the Sand Fort cuesta, the Black prairie, and the terraces and flood plains.

Macon County is underlain by sedimentary rocks of Late Cretaceous age, which are in turn underlain by igneous and metamorphic rocks of pre-Cretaceous age. The deposits of Late Cretaceous age are divided into the Tuscaloosa group, the Eutaw formation, and the Blufftown formation and Mooreville chalk of the Selma group. Terrace and alluvial deposits of Quaternary age overlie the Cretaceous rocks in and adjacent to the flood plains of the Tallapoosa River and other larger streams.

The chief sources of ground water in the county are the Tuscaloosa group and the Eutaw formation. Water for domestic and stock use is obtained also from the Blufftown formation and the terrace and alluvial deposits. Most of the wells listed in this report are used for domestic or stock purposes; however, conditions are favorable in the central and southern parts of the county for the development of ground-water supplies adequate for irrigation and industrial use. Wells yielding 500 g.p.m. (gallons per minute) or more can probably be developed from sands in the Eutaw formation or Tuscaloosa group.

Ground water in most parts of the county contains objectionable amounts of Fe, and in some wells concentrations are as high as 1.2 p.p.m. (parts per million). Water from a few wells in the extreme southern part contains as much as 1,000 p.p.m. chloride and is hard.

This report includes a geologic map and 3 stratigraphic cross sections showing the distribution and thickness of the rock units; maps showing the piezometric surface of water in the Tuscaloosa group and the Eutaw formation, which indicate the effect of natural and artificial ground-water discharge and the direction of ground-water movement; and tables of data on 220 wells and springs, chemical analyses of water from 27 selected wells and springs, and 8 sample logs, 17 drillers' logs, and 11 electric logs of wells and test wells.--Auth.

2-2387. Zhemerov, V.S. CHANGE IN THE CHARACTER OF WATERS IN THE PROCESS OF EXPLOITATION OF OIL HORIZONS IN LOKBATAN: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 11-B, p. 966-970, 2 profiles, 4 tables, 1958, [pub. 1960].

Observations on the progressive changes in formation water chemistry are given to illustrate the hydrogeological features of the oil-bearing formations in SW. Apsheron. The first analyses of the marginal water had an alkaline character, and total mineralization was low. This composition of the water persisted for several years. At a later stage, when the formation pressure was considerably lowered, this water was replaced by hard, highly mineralized water of the calcium chloride and magnesium chloride type. Thus the water at some distance from the margin of the oil appears to be more mineralized and less alkaline than at this margin. The oil fields studied are situated in the main area of intake of atmospheric water for the Apsheron oil fields. Notwithstanding the considerable amount of water, gas, and oil extracted from Apsheron peninsula, no deep infiltration of atmospheric water has occurred in the intake area. Oil exploitation does not lead to freshening of the formation water. It is concluded that the original formation water was hard and was converted into alkaline water under the action of oil, gas, and biochemical processes.--C. Voûte.

2-2388. Miroshnikov, M.V. WATERS OF THE GAS FIELD OF THE STAVROPOL UPLIFT: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 11-B, p. 961-965, 2 maps, 1958, [pub. 1960], 3 refs.

A brief description of the chemical composition and its regional variation in water of pervious beds of several horizons. Two maps figure these variations. The Neogene (middle Sarmation) water is fresh or weakly saline; water exchange is active. The mineralization of the Khadum water-bearing horizon of the Oligocene shows a regular increase in different directions, with an increase of I and Br. The zone of free water exchange passes gradually into a zone of difficult exchange and in one area into a zone of stagnant water with a high mineralization of the calcium chloride type. The I and Br content however as a rule are not dependent on the mineralization but are related to the distribution of gas deposits and the occurrence of sandy rocks. The sandstones of the Abazan suite of the Paleocene are hydrodynamically connected with the sandstones of the Eocene and have the same chemical composition. The Cretaceous water-bearing beds, both limestones of the Upper Cretaceous and sandstones of the Lower Cretaceous, are also hydrodynamically connected with the Paleocene-Eocene. The areas where free water exchange occurs in the Eocene are not favorable for preservation of commercial gas deposits.--C. Voûte.

2-2389. Zinger, A.S. SOME PROBLEMS OF THE HYDROGEOLOGY OF THE PRODUCTIVE HORIZONS OF THE PALEOZOIC OF SARATOV ON THE VOLGA: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 11-B, p. 953-960, 2 diags., 4 tables, 1958, [pub. 1960], 2 refs.

Some data is given on the thickness, porosity, and permeability of productive horizons of the Carboniferous and a small number of analyses of water samples from these horizons. For each horizon an increase of Cl, Ca, Mg, I, and Br is found with depth. The range of sulfate is quite large. In the Elshanka field, however, the water of the Stalinogorsk horizon, although occurring at a relatively shallow depth, is characterized by a rather high mineralization and anomalous Cl/Br index. Neither influx from Devonian water through 1,000 m. of sediments nor the assumption of water circulation through a fault zone are acceptable explanations. Similar anomalies are also found in other areas in the Volga-Ural district. They are attributed to the absence of movement in well sealed-off, isolated, lens-shaped water-bearing horizons. Graphs are given showing the relation between mineralization of the water and depth of occurrence, by which it can be determined whether a sample represents formational water or not. The chemical composition of the deep waters is influenced according to the author by depth of occurrence, geological time, and degree of isolation, but not by the lithology of the enclosing rocks.--C. Voûte.

2-2390. Tolstoi, M.P. SOME PROBLEMS OF THE HYDROGEOLOGY OF THE PALEOZOIC OF THE RUSSIAN PLATFORM: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 10-B, p. 899-906, 4 tables, 1958, [pub. 1960], 13 refs.

Some general features of the hydrogeology in relation to the geology of the Russian platform are briefly stated. It is doubted that the Carboniferous and Devonian strata of the Volga-Ural area form a single hydrodynamic and chemical complex and that the waters migrated from below, from the Devonian through 1,000 to 1,500 m. of rock into the interval tested. A few examples are given of water-bearing beds near to the surface, isolated from each other by clay beds, showing a distinct chemical composition and hydrostatic pressures. A relationship also exists at great depth between the mineralization of the waters and the lithology of the enclosing rocks. Figures are given for the presumed salinity of the sea in the Russian platform area during different stages of the Devonian, Carboniferous, and Permian. The modern seas also show salinity ranges and variations in Cl/Br ratios. Therefore the initial salt concentrations of the connate waters of the Paleozoic may have been relatively nonuniform, and the concentrations now observed cannot serve to determine the degree of isolation of water-bearing beds. Moreover the Cl/Br ratio is not a function of the depth of occurrence. As an illustration of these conclusions 5 analyses of water samples are presented from the upper Permian of the area and 6 from the lower Permian, including the contents of Cl, sulfates, hydrocarbonate, Na, Mg, Ca, Br, I, Cl/Br ratios, and Na/Cl ratios.--C. Voûte.

12. MINERAL DEPOSITS

See also: Geologic Maps 2-2202 through 2-2206; Structural Geology 2-2236; Geochemistry 2-2288, 2-2292; Igneous and Metamorphic Petrology 2-2380.

2-2391. Benson, David. APPLICATION OF THE SPHALERITE GEOTHERMOMETER TO SOME NORTHERN NEW BRUNSWICK SULFIDE DEPOSITS: Econ. Geology, v. 55, no. 4, p. 818-826, 4 figs., June-July 1960, 13 refs.

The base metal sulfide deposits of northern New Brunswick,[Canada], were studied with special emphasis on temperature determinations made with the sphalerite geothermometer.

The Fe content of the sphalerite was determined by X-ray fluorescence analysis of 0.25 mg. samples drilled from the surface of the polished sections. Appreciable differences in the Fe content of adjacent areas of sphalerite are attributed to varying amounts of Fe picked up by the sphalerite from the replaced minerals. Exsolution pyrrhotite was found to be the only reliable evidence that sphalerite formed in the presence of excess Fe.

The temperature of formation of the Heath Steele and Brunswick mines is given as 610°C. at 2,000 bars, equivalent to burial under 15,000 ft. of younger rocks. --Auth.

2-2392. Cate, Robert B., Jr. ORGANIC TRANSLOCATION OF METALS: Southeastern Geology, v. 1, no. 3, p. 83-93, Autumn 1959, 32 refs.

Organic translocation of metals is an important geologic process. Soil scientists have obtained considerable data on this subject in their studies of podzolization. Experiments have shown that plant materials contain substances capable of translocating metals. Organic translocation and subsequent precipitation may be a catalytic type of reaction. This hypothesis may explain certain aspects of metal distribution. Podzolization is a function of parent material, climate, topography, vegetation, and time. It probably reaches its maximum in the humid tropics. Podzolization theory may aid exploration for mineral deposits and help to explain the genesis of some ores. --Auth.

2-2393. Van Wambeke, L. GEOCHEMICAL PROSPECTING AND APPRAISAL OF NIOBIUM-BEARING CARBONATITES BY X-RAY METHODS: Econ. Geology, v. 55, no. 4, p. 732-758, 18 diags., 7 tables, June-July 1960, 71 refs.

The main source of Nb at present is in granites and granitic pegmatites, and in alluvial or eluvial deposits derived from them. The future production of Nb probably will be primarily from carbonatite deposits.

A mineralogical and geochemical study of carbonatite samples from Lueshe, Kivu, Belgian Congo, by the combined X-ray diffraction-fluorescence method indicates that Nb is distributed in pyrochlore, pyroxene, and zircon. Sr is also characteristic of these carbonatites.

The geochemical association of Nb and Sr as well as a high Nb/Ta ratio can be used in alkaline petrographic provinces as the basis of preliminary geochemical prospecting for Nb in carbonatites, their covering soils and the associated superficial Mn-Fe ores. Rapid and semi-quantitative determination of Nb, Sr, Ba, rare earths, Zr and Ti in mineral samples can be made by X-ray fluorescence. For a detailed geochemical prospecting and for the appraisal of Nb-bearing carbonatites 2 direct methods of X-ray fluorescence analysis have been developed. For rapid estimation of the Nb content both direct methods have an accuracy of less than 12% and a sensitivity of 5 to 20 p.p.m. of Nb. Between 100 and 200 analyses can be made per day and per man. The only disadvantage of this method is that the measurements must be made in the laboratory.

Field measurements of radioactivity, paper chromatographic analyses used in conjunction with X-ray fluorescence determinations were used in discovering a Nb-bearing carbonatite in Kivu, Belgian Congo. --Auth.

2-2394. Smith, Arthur Y. HEAVY-METAL (Zn, Pb, Cu) CONTENT OF STREAM SEDIMENTS OF PART OF WESTMORLAND COUNTY, NEW BRUNSWICK: Canada, Geol. Survey, Paper 59-12, 8 p., 7 maps in pocket, 1960, 11 refs.

Amounts of total extractable Zn, Pb, and Cu in stream sediments of the area are low. Anomalous amounts of Zn are widespread and have less meaning than those of Cu and Pb, some of which are definitely related to the dumps of the old Dorchester Cu mines. Some may indicate other deposits of the Dorchester type. A Cu swamp near Upper Sackville has up to 4% Cu concentrated in a black peaty muck.--P. Harker.

2-2395. Cannon, Helen L. THE DEVELOPMENT OF BOTANICAL METHODS OF PROSPECTING FOR URANIUM ON THE COLORADO PLATEAU: U.S. Geol. Survey, Bull. 1085-A, 50 p., 5 illus., 3 maps (2 col. in pocket), tables, 1960, 102 refs.

Botanical methods of prospecting for U on the Colorado Plateau have been developed by the U. S. Geological Survey. Detailed investigation has shown that a relation exists between the distribution of mineralized ground and of specific herbaceous plants. The distribution of these plants is controlled by the presence of Se, S, and other trace elements available in the environment of the U deposit. Investigation also has shown that the U content of trees rooted in ore is significantly higher than that of trees rooted in barren ground. On the flat-lying sediments at lower altitudes of the Colorado Plateau there is definite correlation between major plant zones and stratigraphic units. Chemical differences that occur in a mineralized area within a formation produce, on the other hand, recognizable changes in the plant societies, which may be useful as indicators in prospecting. Information concerning the availability of ions in an ore environment and the absorption of these ions by plant species is important in the development of botanical prospecting techniques.

Plants that act as indicators of U ore on the Colorado Plateau are controlled by the increased availability of Se, S, Ca, or P in the vicinity of ore deposits. The most useful plant species is Astragalus pattersoni; the distribution of this plant has led to the discovery of ore deposits in several districts. Prospecting by mapping the distribution of indicator plants is most effective at altitudes below about 7,000 ft. where the ore horizon is less than 40 ft. below the surface and where the ore contains 0.001% or more Se.

Plants of the mustard family excel in the absorption of U but are not as useful in prospecting by plant analysis as coniferous species of deep-root habit and wide distribution. The average U content of coniferous trees growing in barren areas is 0.5 p.p.m. (parts per million) compared to 1.5 p.p.m. in mineralized ground. Tree samples may be collected on a grid pattern, analyzed for U content by a recently devised chromatographic field test or the older fluorimetric laboratory method, and the values contoured to indicate mineralized ground. The method is applicable in areas of thick forest cover where the ore horizon is at a depth of 70 ft.

Botanical methods of prospecting have been studied and evaluated in 10 districts of the Colorado Plateau. Nearly 11,000 tree samples have been analyzed for U, and indicator plants have been mapped along 50 mi. of outcrop. Both methods are useful in delineating the extent of mineralized ground. A number of ore bodies were found during the period of appraisal. --Auth.

2-2396. Bain, George W. PATTERNS TO ORES IN LAYERED ROCKS: Econ. Geology, v. 55, no. 4, p. 695-731, 13 maps, 2 charts, 6 secs., table, June-July 1960, 32 refs.

Distribution patterns of syngenetic ore bodies in layered rocks correspond in area, symmetry, and metal variation with the rock facies structures. Distribution patterns of epigenetic ore bodies either correspond to antecedent and contemporary tectonic structures or deviate systematically under their influence. Many deposits have metallization, initially syngenetic, redistributed slightly by ground water of varied origin, and these occurrences acquire a tectonic asymmetry while retaining their syngenetic facies limitation. Selected examples of intensively studied deposits are cited and examined critically, and criteria are presented to indicate the syngenesis or epigenesis of metallization as distinct from mineralization.--Auth.

2-2397. Sales, Reno H. CRITICAL REMARKS ON THE GENESIS OF ORE AS APPLIED TO FUTURE MINERAL EXPLORATION: Econ. Geology, v. 55, no. 4, p. 805-817, June-July 1960, 19 refs.

The syngenetic, metamorphic water, and source bed concept theories of ore deposition proposed by Anton Gray, C. L. Knight and others, to explain ores in sedimentary rocks, are challenged on the basis of a survey of the literature and personal observation. A hydrothermal origin for the northern Rhodesian

Copperbelt deposits is indicated by the presence of post-Roan age [Roan series believed to be Precambrian or early Paleozoic] igneous rocks and post-gabbro mineralization, the wide distribution of ore in the various lower Roan lithologic types, and the zoning of the copper-iron sulfide minerals and minor elements.

The proposal by Gray and Knight that igneous rocks are not favorable as guides to nonferrous metal deposits, and Gray's hypothesis that the redistribution of connate waters and their dissolved metals by metamorphic processes was responsible for the emplacement of ores, are rejected as contrary to field evidence. The absence of exposed potential igneous source rocks is shown to be an invalid argument for the proponents of any syngenetic hypothesis. The common association of ore deposits with calc-alkaline intrusive rocks and their derivatives is, however, demonstrated to be convincing evidence that an exploration program based upon a magmatic theory of origin, would have found most of the important known nonferrous metal deposits of the world. It is urged that prospecting be continued on the sound basis of accumulated knowledge of the lithologic and structural facts surrounding known ore deposits.--Auth.

2-2398. Walpole, B.P. THE SOURCE BED CONCEPT: Econ. Geology, v. 55, no. 3, p. 615-617, illus., May 1960.

Discussion of a paper by W.J. Murray and S.R. Carter (GeoScience Abstracts 1-2006). Mineragraphic studies in themselves do not necessarily provide final answers. Certain structures at Mount Isa are interpreted as primary slump structures, not as crenulations. The geometry of a deposit can be established without the reasons for such geometry being understood.--J.A. Chamberlain.

2-2399. Ljunggren, Pontus. A SULFUR MUD DEPOSIT FORMED THROUGH BACTERIAL TRANSFORMATION OF FUMAROLIC HYDROGEN SULFIDE: Econ. Geology, v. 55, no. 3, p. 531-538, illus., map, May 1960, 5 refs.

About 50 km. to the S. of Guatemala City there is a lake of volcanic origin, Ixpaco, diameter 300 m., the bottom of which consists of sulfurous mud, containing about 30 to 60% S. Fumarolic activity is still taking place along the shores of the lake, depositing orthorhombic S crystals and pickeringite. The S of the mud is amorphic μ-S, grain size 0.01-0.1 mm., which, exposed to the air, changes into orthorhombic S. The mud S is formed through the action of S bacteria, that transform H_2S of the fumaroles into S and sulfuric acid, acidifying the lake water to pH 2.3. Total reserves of S mud are estimated at several hundred thousand cubic meters.--Auth.

2-2400. Gavelin, S., A. Parwel, and R. Ryhage. SULFUR ISOTOPE FRACTIONATION IN SULFIDE MINERALIZATION: Econ. Geology, v. 55, no. 3, p. 510-530, illus., map, chart, 7 tables, May 1960, 21 refs.

The isotopic compositions of sulfides and sulfates from various types of sulfide formations have been determined. A description of the preparation of sulfurous minerals for mass-spectrometric analysis and of the mass-spectrometric procedure is given.

The results agree in several respects with previous investigations. Various sulfides representing a continuous mineralization process display no significant divergencies if the early and the late minerals are compared. Nor does the material examined indicate any correlation between isotopic composition and zonal arrangement of minerals and metals around emanative centers, in cases where such zoning is evidenced by the regional geological features. A certain correlation between kind of wall rock and isotopic composition may be indicated. If considerable variations of isotopic compositions are found to exist in an ore district, the range of variation seems to be wider in the low-temperature than in the high-temperature sulfides.

Supergene oxidation of sulfides to sulfates takes place without change in isotopic composition. A subsequent redeposition of supergene sulfides may involve a displacement of the isotope ratios towards lighter S.

Hypogene sulfide mineralization, where both sulfides and sulfates are formed, is apt to cause significant fractionation of the original isotopic composition of the participant S. Local variations indicate that the process may develop differently over short distances. The local character of some isotope exchange reactions is evidenced for instance by considerable variation in the isotope ratios even in a single hand specimen. The range of such variations is generally found to be wider in low-temperature than in high-temperature mineral assemblages.--Auth.

2-2401. Little, W.M. INCLUSIONS IN CASSITERITE AND ASSOCIATED MINERALS: Econ. Geology, v. 55, no. 3, p. 485-509, 12 illus., 2 diags., 9 tables, May 1960, 40 refs.

A study was made of the inclusions in 133 specimens of cassiterite and associated minerals from world wide Sn deposits. From the distribution of inclusion types, it would appear that most pegmatitic Sn deposits have been formed from siliceous melts, but that most other types of deposits have been formed from aqueous solutions. Since these aqueous solutions had the properties of liquids rather than gases, the deposits are more properly classified as "hydrothermal" than "pneumatolytic." Filling temperature measurements on fluid inclusions indicate that most hydrothermal Sn deposition occurs in the 300-500°C. range. Of the previously suggested methods of Sn transportation, alkali-stannate and alkali thiostannate solutions are in accordance with the inclusion data. Additional possibilities are alkali chloro- and alkali fluo-stannate solutions.--Auth.

2-2402. Savage, C.N. NATURE AND ORIGIN OF CENTRAL IDAHO BLACKSANDS: Econ. Geology, v. 55, no. 4, p. 789-796, map, diag., table, June-July 1960.

Fifty or more heavy minerals occur in blacksand placers adjacent to the Cretaceous Idaho batholith. They contain Nb (columbium), Ta, Y, Zr, Hf, U, Th, Ti, and the rare earths. These minerals are of present or future potential value as sources of metals characterized by versatility, including strength and resistance to heat and chemical corrosion.

Natural concentrations of blacksand involve mineral hardness, texture, chemical composition, and specific gravity; mineral size, shape, and degree of roundness; and major alterations in stream regimen affecting competency, capacity, and interruptions of transportation. The latter include climatic changes, lava damming, crustal warping, faulting, and mass-wasting phenomena. Local deep disintegration of bedrock is an important adjunct to blacksand concentration.

The original source of heavy mineral elements is believed to be Precambrian placer accumulations. These concentrations were later partially dispersed by metasomatic reconversion during diastrophic maxima, and indistinct swarms of accessory minerals were produced. New placers were formed again later through the operation of erosional and depositional agents.

Recent blacksand placers derived their heavy minerals from quartz monzonite, granodiorite, diorite, and metamorphic remnants of original country rock commonly found in adjacent exposures of the Idaho batholith. The batholith may appear deceptively normal in these areas. When present, pegmatite and aplite dikes provide an additional source of heavy detrital minerals. The domination of one or more minerals over others in the more recent placers, appears to be related to the domination of similar elemental constituents in earlier original placer deposts.

Thus recent data on both the petrography of the Idaho batholith and the nature and origin of blacksand placers lead to the following conclusions: erosional processes concentrated the first placer ore deposits in the Precambrian; and subsequent events both geomorphic and metasomatic probably played more important roles in the genesis of all types of ore deposits, including placers, than previously has been supposed.--Auth.

2-2403. Wyman, Richard V. **COMMENTS REGARDING ORE GENESIS AT SILVER REEF, UTAH:** Econ. Geology, v. 55, no. 4, p. 835-839, June-July 1960, 3 refs.

Discussion of a paper by Paul Dean Proctor ["Geology of the Silver Reef (Harrisburg) Mining District," Utah Geological and Mineralogical Survey, Bulletin 44, 1953]. Proctor's list of 11 points favoring a syngenetic origin is reproduced and criticized in detail. An epigenetic origin is favored on the basis that mineralization in the area is structurally controlled and because ore-bearing sandstones are altered to a lighter color than adjacent zones.--J. A. Chamberlain.

2-2404. Yates, Robert G., and George A. Thompson. **GEOLOGY AND QUICKSILVER DEPOSITS OF THE TERLINGUA DISTRICT, TEXAS:** U.S. Geol. Survey, Prof. Paper 312, 114 p., 22 pls. incl. illus., 14 maps (under separate cover), 25 figs. incl. maps, secs., 15 tables, 1959, 86 refs.

The Terlingua Hg district, which has produced more than 150,000 flasks of Hg, is in the southern part of the Big Bend region of southwestern Texas. It is a narrow, E.-W. area about 20 mi. long and lies mainly in southwestern Brewster County. The district is connected by graded road with the nearest railroad, 84 mi. N. of its center.

Hg minerals were first discovered in the district in the latter part of the 19th century, but there was no substantial production until 1900. Although there are about 20 mines and many prospects, more than 90% of the Hg came from the Chisos-Rainbow, Mariposa, and Study Butte mines. The most productive years were during World War I; since 1946 the district has been idle. Future production depends upon the discovery of new ore bodies - which will be costly - and the working of deposits now considered of too low grade to be profitable.

The area is mountainous and arid; its sparse vegetation is typical of desert regions. The altitudes range from 2,100 ft. to 4,200 ft. Only 2 streams cross the district, and considerable stretches of these are dry during summer months. Because of the concentration of the scanty rainfall into torrential showers, and because of the wide range in hardness between different rocks, erosion is vigorous and has carved a rugged terrain.

The rocks consist of marine sedimentary rocks of Cretaceous age, and lavas and associated clastic beds and hypabyssal intrusive rocks, all of Tertiary age. Cretaceous sedimentary rocks, beginning with the oldest, are: Devils River limestone (1,500 + ft. thick), Grayson formation (80 to 200 ft.), Buda limestone (50 to 100 ft.), Boquillas flags (about 1,100 ft.), Terlingua clay (about 1,000 ft.), Aguja formation (about 800 ft. of sandstones and clays), and Tornillo clay (600 to 1,000 ft.). All are fossiliferous. Rocks of Tertiary age, collectively termed Chisos volcanics, include tuffs, clays, conglomerates, and lavas, ranging from trachytes through andesites to basalt. Intrusive rocks are in the form of dikes, sills, laccoliths, and plugs and range in composition from rhyolite to basalt. Many igneous rocks have a high content of soda, represented in their mineral compositions as soda orthoclase, sodic pyroxenes, and analcite.

Domes, grabens, and breccia pipes are unusually abundant and well formed. The Terlingua uplift, an irregular dome with a structural relief of several thousand feet, underlies about half the district and is believed to have been formed by igneous uplift. Smaller domes, found throughout the district, are clearly the result of igneous intrusions. The grabens are bounded by normal faults, which together include most of the normal faults of the district. The vertical displacement of the grabens below adjacent blocks is as much as 2,000 ft. Masses of breccia with a pipelike or chimneylike shape have been designated descriptively as breccia-filled pipes, or simply breccia pipes. They range from 75 ft. to 500 ft. in diameter, and one has been explored vertically for more than 800 ft. The nature of the breccia and its walls indicate that the pipes were formed by collapse of bedded rocks into solution caverns.

Hg minerals have been found in veins and tabular and pipelike bodies in both sedimentary and igneous rocks. Cinnabar is the principal ore mineral but there are minor quantities of native Hg, chlorides of Hg, and other rare Hg minerals. Associated minerals are calcite, clay, pyrite, hydrocarbon compounds, and, less commonly, several other minerals. The deposits are classified as: deposits formed in altered rock along the contact between the Devils River limestone and Grayson formation (limestone-clay contact deposits), deposits in calcite veins in the Boquillas flags, deposits in breccia pipes, and deposits in igneous rocks. Their distribution is directly related to fractures and breccia pipes and to the physical and chemical character of enclosing sedimentary rocks and is believed to be indirectly related to the Terlingua monocline and the igneous rocks in the district.

The Hg deposits were formed from hydrothermal solutions of igneous origin at temperatures below 300°C. and pressures locally as high as 30 atm. Deposition of Hg minerals is believed to have been from hydrothermal solutions as cinnabar and as primary chlorides. Mineralizing solutions ascended breccia pipes and fractures, and the ore minerals were deposited in parts of these channels lying less than 2,000 ft. below the surface.--Auth.

2-2405. Stanton, R. L., and R. D. Russell. **ANOMALOUS LEADS AND THE EMPLACEMENT OF LEAD**

SULFIDE ORES - ERRATUM: Econ. Geology, v. 55, no. 4, p. 841, June-July 1960.

Changes in a paper by the authors (GeoScience Abstracts 1-1784). The Keymet and New Larder U mines were inadvertently included in Table 2, "Conformable deposits." The Keymet seems clearly of the vein type. The authors have no detailed information on the New Larder occurrence.--J. A. Chamberlain.

2-2406. Dechow, E. GEOLOGY, SULFUR ISOTOPES AND THE ORIGIN OF THE HEATH STEELE ORE DEPOSITS, NEWCASTLE, N. B., CANADA: Econ. Geology, v. 55, no. 3, p. 539-556, 5 figs. incl. 2 illus., map, 7 tables, May 1960, 21 refs.

The Heath Steele mine is located 35 mi. NW. of Newcastle, New Brunswick, Canada.

Middle Ordovician Tetagouche group rocks, consisting of siliceous and basic volcanic rocks and fine-grained quartz sericite schists and porphyry, have been folded into a steeply plunging recumbent anticline. The ore deposits of Zn, Pb, and Cu are associated with minor folding and or sheared dilatent zones at or near the contact between porphyry and fine-grained sericitic schist.

Mineralogically the sulfide bodies consist of early, euhedral arsenopyrite, magnetite, and pyrite, followed by interstitial pyrrhotite, sphalerite, chalcopyrite, and galena. Minor minerals are tennantite-tetrahedrite, bismuthinite, marcasite, hematite, and some graphite. Supergene minerals consist of chalcocite, covellite, and marcasite with a little native Ag. Little hypogene replacement has taken place between the minerals, which show a "porphyritic" texture.

S isotope ratios have been determined for over 150 sulfide and sulfate specimens from 5 of the 7 ore bodies, and from granite, acid and basic volcanics, porphyry, and sediments. The results indicate that there is no detectable fractionation either during hypogene mineralization or supergene enrichment. The spread (21.82-22.02) covered by the ratios is narrow, and suggestive of a well homogenized source of mineral solutions. The enrichment of S^{34} in the ore sulfides and the presence of graphite, evident from mineralographic studies and mass spectrometric analysis, suggests reduction of original sulfates (known to be enriched in S^{34}) by organic C at temperatures in excess of 600^{o}C. A calculation based on the isotopic exchange reaction between sulfide and sulfate under equilibrium conditions and the spread of the ratios indicates a temperature of 700-800^{o}C. for the source. Finally the ratios determined for sulfides in a gneissic granite close to Heath Steele have the same ratio as the ore. These factors are considered to be diagnostic of a magmatic hydrothermal origin for the ore deposits.

In conclusion the writer believes that an original source bed has been buried until suitable temperatures were reached to cause granitization, reduction of sulfates, and mobilization of the resulting sulfides to form ore deposits at favorable loci.--Auth.

2-2407. Long, A., A.J. Silverman, and J. Laurence Kulp. ISOTOPIC COMPOSITION OF LEAD AND PRECAMBRIAN MINERALIZATION OF THE COEUR D'ALENE DISTRICT, IDAHO: Econ. Geology, v. 55, no. 4, p. 645-658, 3 illus., 3 maps, 4 tables, June-July 1960, 28 refs.

Galena samples representing the vertical and geographical extent of the Coeur d'Alene mining district have been isotopically analyzed for Pb. The isotopic composition is essentially uniform at $Pb^{206}/Pb^{204} = 16.44$, $Pb^{207}/Pb^{204} = 15.58$, $Pb^{208}/Pb^{204} = 36.52$. The common Pb age from this average is about 1,400 million years. This is consistent with other isotope data in the district and may be considered the time of primary mineralization. The original Belt series and its metamorphic equivalents are, therefore, older than 1,400 m.y.

Precambrian Pb in veinlets cutting Laramide monzonite dikes and stocks present positive evidence for sulfide remobilization in Tertiary time in the vicinity of these igneous intrusions. Some minor rock Pb was also introduced as galena during this event.--Auth.

2-2408. Chamberlain, J.A. ON THE URANIUM POSSIBILITIES OF THE SOUTHERN INTERIOR PLAINS OF CANADA: Canada, Geol. Survey, Paper 59-16, 12 p., map, 1960, 36 refs.

No evidence exists of economic sedimentary occurrences of U in the Interior Plains of Canada in spite of the proximity and similarity of certain Canadian sedimentary rocks to those containing U in the United States. Thousands of radioactive logs of wells drilled for oil and gas throughout the Interior Plains indicate that the Exshaw shale [Upper Devonian] is the most radioactive formation yet intersected. Tertiary volcanic rocks, a possible source of U in sedimentary deposits of the United States, are virtually absent in the Interior Plains of Canada.--P. Harker.

2-2409. Robertson, David S., and Nelson C. Steenland. ON THE BLIND RIVER URANIUM ORES AND THEIR ORIGIN: Econ. Geology, v. 55, no. 4, p. 659-694, 4 illus., 8 maps, 9 secs., diag., 3 tables, June-July 1960, 37 refs.

Ore conglomerates of the Blind River [Ontario, Canada], area lie at or near the base of the Huronian sedimentary section in discontinuous, sheetlike, partly overlapping, SE.-trending zones within a major NNE. belt. They are part of a sequence of detrital sediments laid down in a beach and delta environment by a northward transgressing sea.

The Huronian rocks are cut by basic dikes and by quartz veins, both of which have been dated. The ore conglomerates are older than 1,200 m.y. and probably older than 1,700 m.y.

The U minerals, brannerite, uraninite, and a "monazite" complex, occur with a typical detrital assemblage and appear themselves to be detrital.

The ore minerals are considered to be syngenetic and of the age of the conglomerates. Age determinations on the ores suggest that the radioactive minerals have been modified, or that material has been introduced, at 1,300 m.y. and at 600 m.y.

Differences between the Witwatersrand and Blind River are discussed briefly.--Auth.

2-2410. Landis, E.R. URANIUM CONTENT OF GROUND AND SURFACE WATERS IN A PART OF THE CENTRAL GREAT PLAINS: U.S. Geol. Survey, Bull. 1087-G, p. 223-258, 2 maps (1 in pocket), 4 tables, 1960, 11 refs.

The U content of water from various rock units and geologic terranes has been determined in an attempt to locate areas in which large amounts of U in the water might indicate the presence of nearby accumulations of U in the rocks of the central Great Plains.

Water samples were collected from 3 geologic terranes in the report area: the tuffaceous-rocks terrane, of Tertiary and Quaternary age; the shale terrane, of Cretaceous age; and the sandstone terrane, of late Permian through Early Cretaceous age. The average U content of 179 water samples from tuffaceous fluviatile rocks ranging in age from Pliocene to Pleistocene is 6.7 parts per billion (p.p.b.). A total of 48 samples from Cretaceous shale and limestone of marine origin contain an average of 20.4 p.p.b. U. Sandstone, siltstone, and claystone of terrestrial and nearshore marine origin are the predominant rocks of the sandstone terrane, and the 83 water samples collected from or related to these rocks contain an average of 10.2 p.p.b. The average U-content figure derived for the shale terrane may not be representative of the U content of waters from this unit throughout the report area because most of the samples were collected from a small area in which the U content of the waters may be abnormally large. Compared to the shale terrane, the tuffaceous-rocks terrane and the sandstone terrane are both represented by a greater number of samples collected over a much larger area, and the data on the average U content derived for them are believed to be representative of the U content in the report area.

The data on average U content of the different rock units, or groups of rock units, are listed according to the source from which the samples were collected (well, spring, stream, municipal water system, reservoir, or lake), and for some samples by geographic parts of the report area. They are believed to be of more potential use in any future hydrogeochemical exploration in the area than are the data on average U content derived for the 3 geologic terranes. The average U content of groundwater samples from 12 individual rock units or groups of rock units ranges from less than 1.0 to 38 p.p.b. Several rock units were sampled over areas large enough to indicate that waters from the same rock unit in different parts of the report area may range widely in average U content.

Most or all the water samples from certain rock units wherever present in the area, particularly those of Permian and Triassic age, contain large amounts of U. Also, relatively large amounts of U are present in water samples from some parts of the report area, such as the Cimarron River area of westernmost Oklahoma and northeastern New Mexico, and the Rule Creek area of Bent and Las Animas counties, Colorado. Further exploration to determine the source of the U in the water from these rock units and areas may be worthwhile.--Auth.

2-2411. Hilpert, Lowell S., and Robert H. Moench. URANIUM DEPOSITS OF THE SOUTHERN PART OF THE SAN JUAN BASIN, NEW MEXICO: Econ. Geology, v. 55, no. 3, p. 429-464, illus., 6 maps, 13 secs., 2 diags., table, May 1960, 17 refs.

Since 1950 about 50 million tons of U ore has been discovered along the southern margin of the San Juan basin, New Mexico. Here the exposed sequence of sedimentary rocks ranges in age from Permian to Cretaceous, and is associated with intrusive and extrusive rocks of Tertiary and Quarternary age. The U deposits are separable into 3 types - those in sandstones and associated mudstones of the Entrada and Morrison formations of Jurassic age, and Dakota sandstone of Cretaceous age; those in the Todilto limestone of Jurassic age; and one deposit in a pipelike structure in the Morrison formation. The deposits in the clastic sediments are similar to most of the U deposits in other parts of the Colorado Plateau region in type and habit of ore and accessory minerals, in the tabular form of ore bodies, and in their association with some form of carbonaceous material. The deposits in limestone have a somewhat similar mineral assemblage to that of the other deposits in the region but are unique in the type of host rock and their preference for structurally deformed beds. The pipelike deposit is unique.

Although igneous activity has been intense in the eastern part of the area from late Tertiary to Recent time, there is no evidence to suggest a genetic relation between the igneous activity and the U deposits. In fact, what are probably the oldest exposed igneous rocks intrude and displace the deposits.

Three periods of deformation are recognized. The first was during the time between the accumulation of the Entrada and Dakota sandstones, the second in the early to middle Tertiary, and the third in the middle to late Tertiary. Only structures of the first period show an obvious influence on the distribution and localization of the U deposits. From the pattern or frequency of distribution of the known deposits, and on the basis of interpretations from known geologic relations, the deposits seem to be clustered in a zone at least 20 mi. wide N. of the present outcrop. This zone is called the southern San Juan basin mineral belt. Although the concept of this zone, or belt, restricts the favorable ground geographically, the amount of unexplored ground within the limits of the belt is enough to contain several times as much U resources as are now known.--Auth.

2-2412. Fuller, A.O. DISTRIBUTION OF WITWATERSRAND URANINITE: Econ. Geology, v. 55, no. 4, p. 842-843, June-July 1960, 4 refs.

Discussion of a paper by C.F. Davidson (GeoScience Abstracts 1-3144). Stokes formula does not apply to materials of grain size such as are found in the Witwatersrand sediments. The coarseness and lack of rounding of grains comprising the upper Witwatersrand quartzites, and other features, indicate that they were derived from a local coarse-grained primary source of quartz. The conglomerates, however, are well sorted and consist of rounded pebbles, indicating that they were derived from sources different from the quartzites. The uraninite may well be of alluvial origin.--J. A. Chamberlain.

2-2413. Christman, Robert A., Maurice R. Brock, Robert C. Pearson, and Quentin D. Singewald. GEOLOGY AND THORIUM DEPOSITS OF THE WET MOUNTAINS, COLORADO; A PROGRESS REPORT: U.S. Geol. Survey, Bull. 1072-H, p. 491-535, 4 maps (2 in pocket incl. geol. map, scale 1 in. to 1,000 ft.), diags., 7 tables, 1959, 11 refs.

The McKinley Mountain area, a 22-sq. mi. tract of Precambrian rocks that contain Th-bearing veins, lies on the W. flank of the Wet Mountains, Custer and Fremont counties, Colorado. The bedrock in this area is a complexly interlayered sequence of gneisses of metasedimentary origin, migmatite, and granitic gneisses that has been transected by albite syenite stock and numerous NW.-trending dikes, veins, and fractures. Hornblende-plagioclase and biotite-quartz-plagioclase gneisses are the principal metasedimentary rocks; garnet, sillimanite, quartzite, and pyroxene-scapolite zones are locally present. A poorly foliated alaskitic granite gneiss is common as layers ranging from more than 500 ft. in thickness to migmatitic lit-par-lit type layers less than an inch thick. Of less wide distribution, but of similar occurrence, are quartz monzonite gneiss and light-colored granodiorite gneiss. The albite syenite, one of the youngest rocks in the area, is not foliated and is about 595 million years old (late Precambrian), by the Larsen zircon method of age determination. Many of the dikes are similar in composition to the albite syenite stock.

The foliation of the gneisses generally is steep and trends NE. in most of the area. Several northeasterly-trending folds have been mapped in the northern half of the area; a vertically plunging fold occurs in the SW. quarter of the area. Faults, shear zones, and joints, some filled with veins and dikes, trend NW. across the area and cut the foliation at large angles.

More than 800 radioactivity anomalies were found along northwesterly trending veins within the area, and 29 localities were examined outside the area. Most anomalies do not exceed 5 times the background count, but relatively rich concentrations of radioactive elements giving strong anomalies are scattered along the veins in pockets and lenses. The radioactivity, as shown by representative analyses, is due almost entirely to Th. A hydrated thoritelike mineral is visible at some localities; the same mineral doubtless is finely disseminated among red, yellow, and brown iron oxides and (or) hydroxides at radioactive localities where no Th-bearing mineral is visible. Besides iron oxides, and locally, Th minerals, many veins contain abundant carbonate minerals, barite, quartz, and minor quantities of sulfide minerals.--Auth.

2-2414. Hurst, Vernon J. MONAZITE-BEARING PEGMATITES IN THE SOUTH GEORGIA PIEDMONT: Econ. Geology, v. 55, no. 3, p. 610-613, 2 maps, May 1960, ref.

Discussion of a paper by C.W. Fortson and A.T. Navarre (GeoScience Abstracts 1-3142). Monazite-bearing rocks are abundant, not rare. The pegmatite masses at one locality are not in shear zones but are in a plunging anticline. The host rock at a second locality is coronite, not amphibolite. It is not possible to confirm the existence of rhyolite, phyllite, or breccia.-- J. A. Chamberlain.

2-2415. Fortson, Charles W., Jr., and Alfred T. Navarre. MONAZITE-BEARING PEGMATITES IN THE SOUTH GEORGIA PIEDMONT - A REPLY: Econ. Geology, v. 55, no. 3, p. 613-615, May 1960, 7 refs.

Reply to a discussion by V.J. Hurst (see abstract above). Monazite-bearing rocks are scarce, not abundant. It is thought that the area has been subjected to shearing stresses. Two localities are given where rhyolite and breccia occur.--J. A. Chamberlain.

2-2416. Hinze, William J. APPLICATION OF THE GRAVITY METHOD TO IRON ORE EXPLORATION: Econ. Geology, v. 55, no. 3, p. 465-484, 11 figs. incl. maps, diags., graphs, May 1960, 11 refs.

The gravity method has played an increasingly important role in the search for new reserves of Fe ores since the development of highly portable gravimeters capable of a high degree of precision. This method has been used in the search for and study of direct shipping ores, but it has proven to be especially useful in the study of large tonnage, wide, near surface "taconite type" ore bodies that have been the primary concern of the Fe ore industry during the past decade.

The gravity method was first applied to Fe ore exploration as a tool for detecting nonmagnetic ores, but advantages of this method over other exploration methods have also made it useful under certain geological conditions in the study of magnetic ores and regional structures favorable for the occurrence of Fe ore. However, the gravity method is restricted by several limitations that must be realized and understood if the application of the method is to be successful. In addition, the full utilization of the method is dependent on a complete understanding of the density relationships of ores and their contrast with the country rocks. This is made particularly difficult by the wide range of densities of Fe ores that can lead to the association of both positive and negative gravity anomalies with Fe ore bodies. The result is that the amount and quality of information interpreted from the results of gravity surveying is a direct function of the auxiliary geological information available either through geological or other geophysical studies.--Auth.

2-2417. Gundersen, James Novotny. LITHOLOGIC CLASSIFICATION OF TACONITE FROM THE TYPE LOCALITY: Econ. Geology, v. 55, no. 3, p. 563-573, 5 secs., 3 diags., table, May 1960, 9 refs.

The Biwabik Fe formation in the eastern Mesabi district, [Minnesota], the type locality for taconite, consists of interbedded strata of 2 fundamental or basic types, namely massive and thinly bedded. The most significant difference between the various taconite rock types is merely the relative abundance and mineralogy of these 2 types of strata. On this basis, 5 general groups of taconite are proposed. The assignment of a specific rock name to a given rock type, such that it clearly indicates the mineralogy and relative abundance of each of the 2 kinds of strata, is impossible by use of conventional classification methods. Consequently, a simple, although somewhat unorthodox, classification scheme is proposed and is illustrated.--Auth.

2-2418. Krishna Rao, J.S.R. STRUCTURE AND STRATIGRAPHY OF THE MANGANESE DEPOSITS OF VISAKHAPATNAM AND SRIKAKULAM DISTRICTS, INDIA: Econ. Geology, v. 55, no. 4, p. 827-834, 4 maps, 3 secs., table, June-July 1960, 7 refs.

Studies of the Mn deposits of Visakhapatnam and Srikakulam districts indicate that they were originally sedimentary, that they form part of the khondalite series of eastern Ghats and were subjected to severe structural deformation as were the enclosing formations.--Auth.

2-2419. Olson, Jerry C., and E. Neal Hinrichs. BERYL-BEARING PEGMATITES IN THE RUBY MOUNTAINS AND OTHER AREAS IN NEVADA AND NORTHWESTERN ARIZONA: U.S. Geol. Survey, Bull. 1082-D, p. 135-200, 3 illus., 6 maps (3 in pocket), 7 tables, 1960, 46 refs.

Pegmatite occurs widely in Nevada and northwestern Arizona, but little mining has been done for such pegmatite minerals as mica, feldspar, beryl, and lepidolite. Reconnaissance for beryl-bearing pegmatite in Nevada and in part of Mohave County, Arizona, and detailed studies in the Dawley Canyon area, Elko County, Nevada, have shown that beryl occurs in at least 11 districts in the region. Muscovite has been prospected or mined in the Ruby and Virgin Mountains, Nevada, and in the Mohave County, Arizona. Feldspar has been mined in the southern part of the region near Kingman, Arizona, and in Clark County, Nevada.

The pegmatites in the region range in age from Precambrian to late Mesozoic or Tertiary. Among the pegmatite minerals found or reported in the districts studied are beryl, chrysoberyl, scheelite, wolframite, garnet, tourmaline, fluorite, apatite, sphene, allanite, samarskite, euxenite, gadolinite, monazite, autunite, columbite-tantalite, lepidolite, molybdenite, and pyrite and other sulfide minerals.

The principal beryl-bearing pegmatites examined are in the Oreana and Lakeview (Humboldt Canyon) areas, Pershing County; the Dawley Canyon area in the Ruby Mountains, Elko County, Nevada; and on the Hummingbird claims in the Virgin Mountains, Mohave County, Arizona. Beryl has also been reported in the Marietta district, Mineral County; the Sylvania district, Esmeralda County; near Crescent Peak and near Searchlight, Clark County, Nevada; and in the Painted Desert near Hoover Dam, Mohave County, Arizona.

Pegmatites are abundant in the Ruby Mountains, chiefly N. of the granite stock at Harrison Pass. In the Dawley Canyon area of 2.6 sq. mi. at least 350 pegmatite dikes more than 1 ft. thick were mapped, and beryl was found in small quantities in at least 100 of these dikes. Four of these dikes exceed 20 ft. in thickness, and one is 55 ft. thick. A few pegmatites were also examined in the Corral Creek, Gilbert Canyon, and Hankins Canyon areas in the Ruby Mountains.

The pegmatite dikes in the Dawley Canyon area intrude granite and metamorphic rocks which consist chiefly of quartzite and schist of probable Early Cambrian age. The granite is of 2 types: a biotite-muscovite granite that forms the main mass of the stock and albite granite that occurs in the metamorphic rocks near the borders of the stock. The pegmatites were emplaced chiefly along fractures in the granite and along schistosity or bedding planes in the metamorphic rocks.

Many of the Dawley Canyon pegmatite dikes are zoned, having several rock units of contrasting mineralogy or grain size formed successively from the walls inward. Aplitic units occur either as zones or in irregular positions in the pegmatite dikes and are a distinctive feature of the Dawley Canyon pegmatites. Some of the aplitic and fine-grained pegmatite units are characterized by thin layers of garnet crystals, forming many parallel bands on outcrop surfaces. The occurrence of aplitic and pegmatitic textures in the same dike presumably indicates abrupt changes in physical-chemical conditions during crystallization, such as changes in viscosity and in content of volatile constituents.

Concentrations of 0.1% or more beryl, locally more than 1%, occur in certain zones in the Dawley Canyon pegmatites. Spectrographic analyses of 23 samples indicate that the BeO content ranges from 0.0017 to 0.003% in the albite granite, from 0.0013 to 0.039% in aplitic units in pegmatite, from 0.0005 to 0.10% in coarse-grained pegmatite, and from less than 0.0001 to 0.0004% in massive quartz veins.

The scheelite-beryl deposits at Oreana and in Humboldt Canyon, Pershing County, are rich in Be. Twelve samples from the Lakeview (Humboldt Canyon) deposit range from 0.018 to 0.11% BeO, but underground crosscuts have failed to intersect similar rock at depth. Beryl locally constitutes as much as 10% of the pegmatitic ore at Oreana. The beryl was not recovered during W mining at Oreana and is now in the tailings of the mill at Toulon, Nevada. The percentage of beryl is lower than the Oreana ore because of dilution by tailings from other ores milled at Toulon.

Beryl has been found in many pegmatite dikes in the Virgin Mountains. Both beryl and chrysoberyl occur in dikes on the Hummingbird claims, N. of Virgin Peak, in Mohave County, Arizona. Spectrographic analyses of 5 representative samples of the principal dike on the Hummingbird claims range from 0.055 to 0.11% BeO.--Auth.

2-2420. Gillson, Joseph L. **INTRIGUING EXAMPLES OF GEOLOGY APPLIED TO INDUSTRIAL MINERALS:** Econ. Geology, v. 55, no. 4, p. 629-644, June-July 1960, 71 refs.

It is noted that the dollar value of the industrial minerals produced in the United States stands, in relation to the dollar value of the metals produced, in the ratio of $3.2 billion for the nonmetals to $2.2 billion for the metals (1957). The tonnage of crushed stone, and of sand and gravel, each exceeds the tonnage of all the metallic ores produced, and even exceeds the tonnage of solid fuels. Comparatively few geologists have been attracted to the study of industrial minerals. A selection of some of the outstanding problems, mostly geological, but also mineralogical and chemical, offered by the occurrences of the industrial minerals, is the subject of this paper. Asbestos, barite, B, Br, fluorspar, lime and pozzolan cement, pegmatites, sand and gravel, and Ti deposits are discussed.--L.M. Dane.

2-2421. Hershey, Robert E. **THE HIGH-SILICA RESOURCES OF TENNESSEE:** Tennessee, Div. Geology, Rept. Inv. no. 10, 62 p., 2 illus., map, 31 graphs, 8 tables, 1960, 7 refs.

Much of Tennessee is underlain by sands and sandstones, some of which are the high-silica variety. This investigation is based on the study of representative samples from 8 geologic horizons at 24 selected localities throughout the state. Grain-size determinations are tabulated and are shown on histograms and cumulative curves; chemical analyses are also given. Physical descriptions, made from microscopic observations, are presented for each sample.

Some samples did not meet requirements for glass manufacture or other high-silica products, but these were successfully beneficiated by various treatments to qualify them as commercial-grade raw materials. Beneficiation procedures are described and the results are evaluated. Basic beneficiation techniques included: blunging of the samples in water, blunging in water with addition of detergent, and electromagnetic separation.

Grain-size determinations and chemical analyses were made on the beneficiated samples, and the per cent of recovery was calculated. Samples from 5 localities were beneficiated to second quality glass grade by simple washing; samples from 4 other localities qualified for the same grade after additional beneficiation. Samples from all other localities could be classified in the range from fourth to ninth quality glass grade after beneficiation. Most of the samples contained 75% or more of the sample in the acceptable grain size range.--R.J. Floyd.

2-2422. Cameron, Eugene N., and Paul L. Weis. **STRATEGIC GRAPHITE: A SURVEY:** U.S. Geol. Survey, Bull. 1082-E, p. 201-321, 18 maps (3 in pocket), sec., 6 graphs (1 in pocket), 2 tables, 1960, 286 refs.

Strategic graphite consists of certain grades of lump and flake graphite for which the United States is largely or entirely dependent on sources abroad. Lump graphite of high purity, necessary in the manufacture of C brushes, is imported from Ceylon, where it occurs in vein deposits. Flake graphite, obtained from deposits consisting of graphite disseminated in schists and other metamorphic rocks, is an essential ingredient of crucibles used in the nonferrous metal industries and in the manufacture of lubricants and packings. High-quality flake graphite for these uses has been obtained mostly from Madagascar since World War I. Some flake graphite of strategic grade has been produced, however, from deposits in Texas, Alabama, and Pennsylvania. The development of the C-bonded crucible, which does not require coarse flake, should lessen the competitive advantage of the Madagascar producers of crucible flake.

Graphite of various grades has been produced intermittently in the United States since 1644. The principal domestic deposits of flake graphite are in Texas, Alabama, Pennsylvania, and New York. Reserves of flake graphite in these 4 states are very large, but production has been sporadic and on the whole unprofitable since World War I, owing principally to competition from producers in Madagascar. Deposits in Madagascar are large and relatively high in content of flake graphite. Production costs are low and the flake produced is of high quality. Coarseness of flake and uniformity of the graphite products marketed are cited as major advantages of Madagascar flake. In addition, the usability of Madagascar flake for various purposes has been thoroughly demonstrated, whereas the usability of domestic flake for strategic purposes is still in question.

Domestic graphite deposits are of 5 kinds: deposits consisting of graphite disseminated in metamorphosed siliceous sediments, deposits consisting of graphite disseminated in marble, deposits formed by thermal or dynamothermal metamorphism of coal beds or other highly carbonaceous sediments, vein deposits, and contact metasomatic deposits in marble. Only the first kind comprises deposits sufficiently large and rich in flake graphite to be significant potential sources of strategic grades of graphite. Vein deposits in several localities are known, but none is known to contain substantial reserves of graphite of strategic quality.

Large resources of flake graphite exist in central Texas, in northeastern Alabama, in eastern Pennsylvania, and in the eastern Adirondack Mountains of New York. Tonnages available, compared with the tonnages of flake graphite consumed annually in the United States, are very large. There have been indications that flake graphite from Texas, Alabama, and Pennsylvania can be used in clay-graphite crucibles as a substitute for Madagascar flake, and one producer has made progress in establishing markets for his flake products as ingredients of lubricants. The tonnages of various commercial grades of graphite recoverable from various domestic deposits, however, have not been established; hence, the adequacy of domestic resources of graphite in a time of emergency is not known.

The only vein deposits from which significant quantities of lump graphite have been produced are those of the Crystal Graphite mine, Beaverhead County, Montana. The deposits are fracture fillings in Precambrian gneiss and pegmatite. Known reserves in the deposits are small.

In Texas, numerous flake-graphite deposits occur in the Precambrian Packsaddle schist in Llano and Burnet counties. Graphite disseminated in certain parts of this formation ranges from extremely fine to medium grained. The principal producer has been the mine of the Southwestern Graphite Co., W. of the town of Burnet. Substantial reserves of medium-grained graphite are present in the deposit mined by the company.

In northeastern Alabama, flake-graphite deposits occur in the Ashland mica schist [Precambrian] in 2 belts that trend northeastward across Clay, Coosa, and Chilton counties. The northeastern belt has been the most productive. About 40 mines have been operated at one time or another, but only a few have been active during or since World War I. The deposits consist of flake graphite disseminated in certain zones or "leads" consisting of quartz-mica-feldspar schists and mica quartzite. Most of past production has come from the weathered upper parts of the deposits, but unweathered rock has been mined at several localities. Reserves of weathered rock containing 3 to 5% graphite are very large, and reserves of unweathered rock are even greater.

Flake graphite deposits in Chester County, Pennsylvania, have been worked intermittently since about 1890. The deposits consist of medium- to coarse-grained graphite disseminated in certain belts of the Pickering gneiss [Precambrian]. The most promising deposit is one worked in the Benjamin Franklin and the Eynon Just mines. Reserves of weathered rock containing 1.5% graphite are of moderate size; reserves of unweathered rock are large.

In the eastern Adirondack Mountains in New York there are 2 principal kinds of flake-graphite deposits: contact-metasomatic deposits and those consisting of flake graphite disseminated in quartz schist. The contact-metasomatic deposits are small, irregular, and very erratic in graphite content. The deposits in quartz schist are very large, persistent, and uniform in grade. There are large reserves of schist containing 3 to 5% graphite, but the graphite is relatively fine grained.--Auth.

2-2423. Maher, Stuart W., and Joe P. Walters. THE MARBLE INDUSTRY OF TENNESSEE: Tennessee, Div. Geology, Inf. Circ. 9, 25 p., 5 illus., map (in pocket, scale 1:633,600), 1960, 16 refs.

The marble industry of Tennessee began in 1838, with the opening of a quarry about 7 mi. N. of Rogersville. At the present time 7 companies operate 14 quarries, in the general vicinity of Knoxville.

Commercial deposits are associated chiefly with the Holston formation of Ordovician age. Although Tennessee "marble" is actually a coarsely crystalline limestone, its appearance and physicochemical properties are superior in many respects to some true metamorphic marbles. Tennessee is one of the nation's leaders in the production of marble, a considerable amount of which is exported to other states.

The major use of Tennessee marble is as dimension stone for interior and exterior construction. Companies also sell marble for monuments, statues, art works, and grave markers. Scrap marble is used for making terrazzo, grit for fowls, crushed stone, and lime.--R.J. Floyd.

2-2424. Turneaure, Frederick S. A COMPARATIVE STUDY OF MAJOR ORE DEPOSITS OF CENTRAL BOLIVIA. PART II: Econ. Geology, v. 55, no. 3, p. 574-606, sec., 5 tables, May 1960, 76 refs.

See GeoScience Abstracts 2-1285 for abstract of entire article.

See also: Areal and Regional Geology 2-2215; Structural Geology 2-2242; Geohydrology 2-2387, 2-2388, 2-2389; Engineering Geology 2-2451.

2-2425. National Petroleum Bibliography. PETROLEUM SOURCEBOOK, 1959; A REGIONAL BIBLIOGRAPHY OF PETROLEUM INFORMATION. Edited by Curtis Stevens: 234 p., Amarillo, Texas, 1960.

More than 5,000 references compiled from approximately 1,500 publications are listed in this worldwide bibliography. The references, mainly to material published during 1958, are classified by region, country, state or province, and cover the following: North America (United States, Canada, Mexico), Central America and West Indies, South America, Europe, Near East, Africa, Far East, Oceania and Malaysia, Antarctica. Publications of the trade press, professional societies, state and federal agencies, and mapping, statistical, and financial institutions are included. Appendices contain the following lists: 1) bibliographies, indexes and price lists published during 1957; 2) directories published during 1957; 3) periodical publications included in Petroleum Sourcebook; 4) names and addresses of publishing agencies for Petroleum Sourcebook material.--A.C. Sangree.

2-2426. Kaufman, V.P., and I.S. Guzik. THE PROBLEM OF DETERMINATION OF THE ECONOMIC EFFECTIVENESS OF GEOLOGIC PROSPECTING OPERATIONS: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 12-A, p. 1000-1005, 3 tables, 1958, [pub. 1960], 8 refs.

The problem of an economic evaluation of prospection work is briefly discussed, illustrated with figures from Azerbaijan. Not all geologists or oil economists agree upon the manner in which the obtained or expected results of geological exploration have to be compared with the expanded material or volume of work. It is proposed to examine the problem not only for oil but for oil and gas together. It is also recommended to take into account the quality of the oil and the cost of its further refinement. At the present time the economic effectiveness of geologic operations in practice is expressed as the cost of preparation of a ton of reserves and the specific expenditure of meterage per ton of increase of oil and gas reserves.--C. Voûte.

2-2427. Shangin, S.N. EXPERIMENT AT HYDROGEOLOGICAL INVESTIGATIONS IN THE EXPLOITATION OIL FIELDS: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 11-A, p. 949-952, map, diag., 2 tables, 1958, [pub. 1960], 4 refs.

A summary of observations made during exploitation of the Zolnyy gulch structure in the Volga region. Owing to a greatly diminishing formation pressure the gas/oil ratio was increased considerably and as a corrective measure marginal flooding was proposed. Injection for practical reasons was carried out on one side of the structure only. Formation pressure was restored and maintained by injecting somewhat less than half the volume (at formational condition) of oil withdrawn, the balance being compensated by an inflow of formation water. The direction of advance of the oil-water contact was from the injection wells towards the producing wells. It is recommended to include accurate hydrogeological investigations as common practice in all exploitation and exploration activity.--C. Voûte.

2-2428. Kotyakhov, F.I. DETERMINATION OF THE PHYSICAL PARAMETERS OF OIL-BEARING ROCKS FOR CALCULATION OF OIL RESERVES IN DEPOSITS ACCORDING TO ELECTROMETRIC AND RADIOMETRIC DATA: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 10-B, p. 879-883, graph, 1958, [pub. 1960], 7 refs.

A theoretical description of a method of computation, by which the coefficient of total porosity and the water saturation of oil-bearing strata can be calculated on the basis of measurements of the coefficient of relative electrical resistance from the electrical log, the coefficient of absorption of gamma radiation from the gamma log, the mineralization of the connate water, and the densities of oil and water under formational conditions. It is based on an empirical formula expressing the relationship between the coefficient of relative electrical resistance of an oil-bearing stratum, its coefficient of total porosity, its coefficient of water saturation, the initial specific electrical resistance of the oil-bearing stratum, and the specific electrical resistance of the connate water. The solution of the equation with its 3 unknowns can be found using the numerical relationship between the coefficient of absorption of gamma rays and the density of a rock. Thus the coefficient of total porosity can be expressed in relation to the coefficient of gamma ray absorption, the densities of oil and water under formation conditions, and the coefficient of relative electrical resistance of the stratum. If the same measurements are carried out a second time on the flooded, worked-out part of an oil stratum, the coefficient of oil output can be found as well. By using the results of core analysis, electrical and radiometric data it is thus possible to calculate both the absolute and commercial oil reserves for a deposit.--C. Voûte.

2-2429. Eremenko, N.A. BITUMENS OF ROCKS AND THEIR GENETIC RELATIONSHIP TO OIL: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 11-B, p. 971-981, 7 figs., 5 tables, 1958, [pub. 1960].

A few examples are given to show the genetic relationship between oils and bitumens of rocks. Igneous and metamorphic rocks are omitted from the discussion. The example of the NE. Caucasus demonstrates that a number of cycles of bitumen and oil formation can be distinguished in relation to the regional geological history. During each cycle the whole process took place from accumulation of organic material to its conversion into bitumen and possibly to the formation of commercial concentrations. It is possible to make chemical comparisons between oils of the same age not only in adjacent fields but also in natural outcrops. The Rudkin horizon of the middle Frasnian substage of the Devonian in the central part of the Russian platform illustrates a regional variation in facies to be linked with the bitumen content and changes in its chemical composition from acid in the W. to reduced in the E. in the Ural-Volga oil regions. Furthermore the similarity existing between different fractions of oils and bitumens is shown. Comparisons are made between the naphthene-methane hydrocarbons of the most reduced fraction, the carboxylic acids and phenols of the acid fraction, the infrared spectra of the paraffin-naphthene fraction, and the luminescence spectra of chloroform solutions. Detailed investigations show, however, that no complete identity exists. Thus in some cases perylene has been found in bitumen but not in oil of the same age. The infrared spectra of benzol tars and the aromatic fraction also show differences between the bitumens and oils of a same horizon.--C. Voûte.

2-2430. Mitura, F. GAS-BEARING POSSIBILITIES OF THE UPPER SILESIAN COAL BASIN: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 11-B, p. 982-987, map, 1958, [pub. 1960], 7 refs.

Some facts are given and arguments briefly stated in favor of the idea that coalification and degasification of coals depends on tectonic processes. Gas is produced in the metamorphism of coals, the greatest amount being related to the sections underlying the Carpathian overthrust and also the contacts of the Carpathian flysch overthrust on the eroded surface of the folded Carboniferous. It is found in pores in the coal, in the sandstones and conglomerates associated with the coal, but also in the base of the flysch and sands of the Miocene into which it migrated. The cause of the presence of many large gas deposits has to be sought in young folding movements, which under certain circumstances created conditions for renewed formation of gas in Carboniferous sediments, where it occurs under high pressure. In some other cases however they only acted in promoting migration of the gas to higher zones, where it shows low pressure only. In the western Carpathians only few indications are found of gas related to the degasification of oil, in contrast to the large scale development of coal gases.--C. Voûte.

2-2431. Petersile, I.A. HYDROCARBON GASES IN KHIBIN: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 10-B, p. 907-913, map, diag., table, 1958, [pub. 1960], 6 refs.

The geology and petrography of the Khibiny nepheline syenite intrusive body are briefly described. During mining operations in the apatite-nepheline deposits gas explosions took place twice, upon which a study was made of the gases. These mainly consist of methane with minor quantities of ethane, propane, butane, and heavier hydrocarbons, H, O, N, and other inert gases. The investigations covered gases in the free state, recovered from boreholes and in the mines, and gases in the open and closed pores of the rocks. Surface geochemical investigations were carried out by drilling boreholes to a depth of 1 to 1.5 m. The bitumens present in the igneous rocks were also studied carefully. Indications are given on the methods of analysis used for the gases and the bitumens. The permeability of rock specimens was found to be small. Variations of gas content in boreholes in the course of 2 to 3 months shows that the gas moves along micro fractures and communicating pores. The gas contents are given for the different types of rock occurring in the area. There is a noteworthy relationship between the gas content of hydrocarbon gases and the alumine of the rocks. None occurs beyond the limits of the intrusive body in the Archean gneisses or Proterozoic sedimentary volcanic suite. The position of the Khibiny mass excludes the penetration of hydrocarbon gases into it from any sedimentary units. The hydrocarbon gases therefore are of inorganic origin, alumine possibly having acted as a catalyst.--C. Voûte.

2-2432. Swain, Paul. WORLD-WIDE OFFSHORE AREAS BEGIN YIELDING THEIR PROMISED RICHES: Oil & Gas Jour., v. 58, no. 23, p. 93-98, 3 illus., 3 maps, June 6, 1960.

Offshore drilling activity is no longer confined to the Gulf of Mexico. In the Persian Gulf 5 mobile drilling barges and 2 fixed platform drilling set ups are operating. Discoveries have been made off the Neutral Zone, off the Trucial Coast at Manifa off Saudi Arabia in addition to the now 10-year old Safiniya oil field which is also off Saudi Arabia just N. of Manifa.

In the Gulf of Paria the Trinidad side has the most to show. The first established production was at Soldado, 14 mi. W. of Trinidad's Point Fortin jetty and only 7 1/2 mi. E. of the international boundary. Other productive areas have been established to the N. of Soldado. On the Venezuelan side a well tested 1,500 barrels daily from 2 sands between 4,000 and 4,500 ft.

In the Sea of Japan an important field has been found off the Japanese home island of Honshu.--N. Street.

2-2433. Bokman, John. OIL GRAVITIES IN THE WESTERN CANADA BASIN: Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 3, p. 81-87, map, 2 diags., graph, 2 tables, March 1960, 11 refs.

A plot of 415 points from all reservoirs on a scatter diagram of oil gravities versus depth in the western Canada sedimentary basin indicates that oil gravity is a function of reservoir depth. Diagrams for the individual reservoirs show the same relationship. A contour map of oil gravities has a generally NW.-SE. strike with values increasing from 6° API in the NE. to 55° API in the SW.

The relationship between gravity and depth is considered to be the result of temperature and pressure as well as other less clearly defined factors. Cardium, Viking, Nisku, and Leduc oils are considered to show typical depth-gravity relationships for the basin. Mississippian oils appear to represent a separate group of values; this is probably due to their position in traps at a major unconformity. Blairmore and Beaverhill Lake oils show less variation with depth than other oils and also appear anomalous in other respects.--Auth.

2-2434. Champlin, J.B.F., and H.N. Dunning. A GEOCHEMICAL INVESTIGATION OF THE ATHABASCA BITUMINOUS SANDS: Econ. Geology, v. 55, no. 4, p. 797-804, 3 diags., 3 tables, June-July 1960, 15 refs.

The Athabasca bituminous sands, Canada's largest petroleum reserve, lie in northern Alberta where they outcrop along the headwaters of the Athabasca river. The accessibility that makes it possible to exploit the formation by mining also permits study of the interrelationships of the asphaltic oil, reservoir materials, and the geochemically significant porphyrin materials.

The metal-porphyrin and porphyrin aggregate contents of the Athabasca oil fractions were determined quantitatively. These fractions also were further subdivided by alcohol extraction and extensive chromatography. The metal-porphyrin contents of these fractions corroborated the bulk analyses and revealed the presence of a Ni-porphyrin complex in addition to the previously established predominant V-porphyrin complex.

The Athabasca oil is similar to other asphaltic oils, of high V content, in porphyrin and metal contents as well as in many of its bulk properties. Correlations of the geochemical and petrological data indicate that the bulk of the Athabasca oil has had a sheltered existence; one relatively free of weathering influences. Identification of the N-porphyrin complex with larger amounts of the V-Ni complex is another indication of the similarity of this oil to other V-rich oils.--Auth.

2-2435. Sullivan, Robert E. CONSERVATION OF OIL AND GAS IN NORTH DAKOTA, A LEGAL HISTORY 1948-1958: North Dakota Geol. Survey, Bull. 33, 12 p., 1960, 55 refs.

North Dakota has continued to distinguish itself in the field of oil and gas conservation. It has kept pace with developments through amendments to its basic conservation law and through the approach of its Industrial Commission in the administration of regulations. Although it has been suggested that a new conservation agency be created, experience elsewhere shows that all that is necessary is to vest sufficient authority in the existing commission and to staff it with properly qualified personnel. A compulsory unitization law is desirable to avoid possible future waste.--M. Russell.

2-2436. Lloyd, Joel J., and Gabriel Dengo. CONTINUED DRILLING MAY UNCOVER OIL IN GUATEMALA'S PETEN: Oil & Gas Jour., v. 58, no. 18, p. 208, 210, 212, map, 2 secs., May 2, 1960.

Peten basin is on the Atlantic slope of Guatemala within the Departments of Peten, Alta Verapaz, and Izabal. It is not actually a completely contained geosyncline but a small part of a great basin extending N. and NW. into Mexico and eastward through British Honduras. The structure is discussed in terms of 5 major structural units: the Alta Verapaz fault belt, the Foreland, the Chiquibul embayment, the Libertad arch, and the North basin.

Stratigraphically the oldest sediments are Pennsylvanian deep water deposits resting on a basement complex of igneous and metamorphic rocks. Elevation in the Permian resulted in the deposition of the Chochal formation of interbedded fossiliferous limestone, dolomite, sandstone, and shale. Total emergence at the end of the Permian was sustained through Triassic and most of Jurassic times and most of the Upper Jurassic Todos formation is composed of red sandstones and conglomerates with minor brackish water deposits, littoral shales, and some evaporites. The Jurassic-Cretaceous contact is conformable and Cretaceous beds are composed almost entirely of limestone, dolomite, and anhydrites. There is an unconformity between the Cretaceous and Eocene.

The black shales and fetid carbonates of the Permian-Pennsylvanian strata are considered to be the oil source rocks. Five wells have been drilled, of which 2 were only doubtfully in the basin area and did not reach the Cretaceous. The other 3 found oil shows in the Cretaceous limestone and dolomite.--N. Street.

2-2437. CONTRIBUTION OF THE OIL AND GAS EXPLORATION MEN TO THE SEVEN YEAR PLAN OF 1959 TO 1965: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 12-A, p. 991-994, 1958, [pub. 1960].

In connection with a planned growth of heavy industries of 85% to 88% in the U.S.S.R., the oil output should increase to at least twice the output of 1958 and reach 230 to 240 million tons. Gas production is expected to increase 5 times to 150 billion m.^{3}. The important oil and gas discoveries of the last few years in European Russia and Asia are mentioned. Special attention should be given to introducing new methods of exploration, and to the new but insufficiently explored areas in central Asia, Kazakhstan, Siberia, and the Far East. Goals are set for the increase in volume of geological exploration, drilling, and geophysical investigations among which seismic work has top rank. It is expected that with the accomplishment of the planned exploration work the Soviet Union will surpass the U.S.A. in proved oil reserves and rival them in gas reserves.--C. Voûte.

2-2438. Kinzikeev, A.R., I.G. Poluyan, and S.A. Sultanov. OIL POSSIBILITIES OF THE COAL-BEARING HORIZON OF THE BAVLIN OIL FIELD: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 10-A, p. 873-878, 3 maps, chart, 1958, [pub. 1960], 2 refs.

The detailed stratigraphy and lithology are described of a horizon of sandy-clayey terrestrial sediments and its stratigraphic position debated at the top of the Tournaisian stage of the lower Carboniferous. Two different sandy-silty beds are found to be commercially oil bearing on a large structural uplift in the Tatar A.S.S.R., on which more than 250 wells have been drilled into the underlying Devonian deposits. The water-oil interface has been traced. Plans are made for development of the horizon by drilling and placing in operation 158 wells in the 1959-1965 period.--C. Voûte.

2-2439. Korotkov, S.T. PROGRESSIVE METHODS OF DEVELOPMENT OF OIL FIELDS OF THE KRASNODAR AREA: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 11-A, p. 917-922, 2 graphs, 1958, [pub. 1960], 9 refs.

A summary of the history of production of several oil fields in the Krasnodar area from 1928 onward in relation to daily yields, gas-oil ratios, drop of formation pressures, percentage of recovery, and conservation measures. The influence of water drive and gas drive on daily yields and final percentage of recovery are mentioned. Conservation measures were accidental, in part owing to the period of shutdown during World War II. Since 1945, air injection and marginal water injection have become standard practice to maintain stabilized formation pressures and to improve oil recovery.--C. Voûte.

2-2440. Mitin, N.E., and R.S. Bezborodov. ON THE CONDITIONS OF OCCURRENCE AND POSSIBILITIES OF OIL- AND GAS-BEARING CAPABILITIES OF THE JURASSIC DEPOSITS OF THE BARAKAYEV OIL FIELD: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 11-A, p. 923-929, 2 maps, 2 profiles, 1958, [pub. 1960].

A concise description of the stratigraphy and tectonic structures of an area situated in the northwestern Caucasus, to the SE. of Maikop. The oldest rocks penetrated by drilling belong to the Lower Jurassic. Strong tectonic movements of the Adygey (pre-Callovian) phase of folding preceded deposition of the Upper Jurassic sediments, as a result of which the Lower-Middle Jurassic rocks form an independent structural stage, unconformably covered by the transgressive Callovian deposits. Other transgressive phases occurred in the Lower Cretaceous and during the Eocene-Oligocene. In the Barahagev field oil and gas deposits have been found at 4 horizons in the

Middle and Upper Jurassic. They are controlled by stratigraphic traps, while the presence of faults determined the distribution of pools in individual blocks. Some further possibilities of oil and gas occurrences might be present in the fissured carbonate rocks of the higher part of the Upper Jurassic sequence.--C. Voûte.

2-2441. Ovanesov, G.P., and M.F. Martev. PROCEDURE FOR EXPLORATION OF STRUCTURES IN THE BASHKIR ASSR: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 10-A, p. 851-858, map, sec., 1958, [pub. 1960].

An outline of the main paleogeographical and structural features in the Cis-Ural downwarp to the W. of the Ural mountains and in the platform area of Bashkir lying at the E. margin of the Russian platform. In the Cis-Ural downwarp buried reef masses are found of Sakmaro-Artinsk age (lower Permian) and narrow faulted N.-S. directed brachyanticlinals. Often the structures of the lower Permian and older beds are very different from those of the higher Permian deposits. In the platform region the sediments are homogeneous over large areas and more persistent in thickness. Large, gently folded structures are found, but again the upper Permian structures often do not reflect those of the older horizons. In many cases this is due to plastic deformation of the Kungur (lower Permian) gypsum and salt beds. Gaps occur in the sedimentary succession, caused by tectonic movements. A number of structures are mentioned, revealed by geophysical prospecting and drilling. Because of the various structural stages in the Paleozoic several prospecting methods have to be used alternatively or in combination. In the Cis-Ural depression, exploration is conducted by electrical and gravity prospecting. In some areas use of the gravity method is hampered by the gypsum-salt deposits of the Kungur suite. The seismic reflection method is not always suitable either. Some data are given on the refraction work.--C. Voûte.

2-2442. Engurazov, I.I., and M.B. Ezdrin. PROBLEM OF THE EXPLORATION OF STRUCTURES IN THE SARATOV TRANS-VOLGA REGION: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 12-A, p. 995-1000, 2 maps, 1958, [pub. 1960], 2 refs.

Commercial gas and gas-oil deposits have been determined in the Devonian, Carboniferous, and Permian sediments. The position of this region on the SE. flank of the Russian platform between the oil and gas fields of the Kuybyshev, Saratov, and Orenburg districts is very favorable. The Mesozoic rocks unconformably overlap the eroded surface of the Paleozoic. A thick unit of Permian clay-anhydrite and carbonate sediments dips regionally to the E. and SE., together with the underlying Carboniferous. In places strong deformations have occurred, and there are several uplifts. In the southern part, where salt tectonics have developed, the general subsidence passes into a steep tectonic terrace bordering the Pri-Caspian depression.

The Carboniferous and Permian sequences show much variation in thickness; unconformities also occur within the Permian. Upper Permian structures do not always correspond to structures of the older strata, which makes exploration difficult. Seismic studies have not been successful in the Saratov and Stalingrad areas for several reasons: 1) the shallow depth of the first rigid boundary which gives rise to disturbing multiple waves; 2) a thick cover of loose boggy clay absorbing the energy; and 3) the abruptly changing thickness of the Permian gypsum-anhydrite unit.--C. Voûte.

2-2443. Krems, A. Ya. PRINCIPAL FEATURES OF THE GEOLOGIC STRUCTURE OF THE TIMAN-PECHORA PROVINCE AND THE OUTLOOK FOR THE SEARCH FOR RICH POOLS OF GAS AND OIL. Translated by Walter S. White: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 10-A, p. 843-851, map, table, 1958, [pub. 1960].

The paleogeography and paleotectonic features which have been worked out for an area extending between the Barents Sea, the Urals and the Perm district are outlined. The basement is formed by a thick series of late Proterozoic slates, whereas it consists of Archean in neighboring parts of the Russian platform. The geologic history of the area shows 2 independent periods. Five to six thousand meters of sediments, deposited in a geosyncline, were subjected to orogenesis at the end of the Proterozoic. Several ridges with a NW. trend were formed, after which the Timan geosyncline was transformed into the northeastern margin of the Russian platform. During the Paleozoic the various ridges and troughs were subjected to alternate uplifting and downwarping, troughs being turned into arches and vice versa. As a result the thickness of the Devonian, Carboniferous, and Permian varies considerably. Oil and gas accumulated occasionally in local structures but more often by migration into the uplifts. Downward movements were particularly extensive during the Kungur stage of the Permian, when a salt basin of very large dimensions formed. In the Pfalz phase of the Hercynian orogeny the present structures were formed. The area is an extension of the Volga-Ural region and therefore potentially very important. Commercial quantities of oil and gas have been developed or proved on numerous structures and at various horizons of the Devonian as well as of the terrestrial Carboniferous. Similar favorable prospects are expected farther to the NE.--C. Voûte.

2-2444. Gavrish, V.K. THE OIL AND GAS PROSPECTS OF THE CARBONIFEROUS SEDIMENTS OF THE KREMENCHUG PROJECTION OF THE DNIEPER-DONETS DEPRESSION: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 10-A, p. 867-872, map, 1958, [pub. 1960], 11 refs.

A brief description is given of the main paleogeographical and structural features indicative of stratigraphic traps, which up to now have been neglected in this area. The relief and structure of the crystalline basement and a number of unconformities within the Carboniferous, Permian, Triassic, Jurassic, and Cretaceous are mentioned. The pre-Tertiary surface is figured as well. To the N. of Kremenchug lies an area where uplifting started before the Permian and continued until after the Upper Cretaceous. In this area migration of oil and accumulation has occurred in beds of the lower and middle Carboniferous. The most favorable places for stratigraphic traps are expected to be the sediments of the Visean (lower Carboniferous), which are overlapped unconformably by middle Carboniferous. Data are given on the content of the bituminous matter, porosity and permeability of lower Carboniferous sandstones.--C. Voûte.

2-2445. Makhankov, O.M. GEOLOGIC MAKE-UP OF THE LOWER KURA DEPRESSION AND SOME

PROBLEMS OF THE FORMATION OF OIL AND GAS DEPOSITS: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 11-A, p. 930-937, profile, 1958, [pub. 1960], 4 refs.

The paper discusses the oil and gas deposits of the Pliocene in terms of time of migration of the hydrocarbons, their accumulation in stratigraphic and structural traps, and their redistribution owing to later faulting. The lower Kura depression forms a part of the large depression which extends southeastward between the greater Caucasus on the NE. and the lesser Caucasus and Talish mountains and which passes beneath the Caspian Sea. It is filled with at least 4,300-4,500 m. of Pliocene deposits, the bottom of which is not known. They are covered with Pleistocene and recent sediments up to 1,000 m. thick. Tectonic movements made themselves felt during the entire Pliocene and Pleistocene, resulting in local unconformities and great variation in thickness of the different subdivisions of the stratigraphical sequence. There is also much variation in lithology of the individual beds. A series of tectonic zones is recognized, consisting of asymmetrical brachyanticlinals, complicated by longitudinal faults of great length and by large slips. The faulting occurred in the very recent geologic past, as they cut through Pleistocene beds. All structures described carry to some extent indications of mud volcanoes, which probably are related genetically to the faulting.--C. Voûte.

2-2446. Ivanchuk, P.K., and A. Ya. Edelshtein. QUESTION OF THE GAS AND OIL POTENTIAL OF THE MOLDAVIAN S.S.R.: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 12-A, p. 1006-1010, map, 2 secs., 1958, [pub. 1960].

A brief description of the subsurface continuation of the Dobrudzka range which, with the SW.-subsided part of the Russian platform and the fore-mountain Cis-Dobrudzka downwarp, forms the main geotectonic elements of the area. The core of the swell is composed of Triassic and Paleozoic rocks, covered by Jurassic, Lower Cretaceous, Eocene, Miocene, and Pliocene. Gas has been found largely in the middle Sarmatian (Miocene); the older sediments contain small accumulations. In the Valeny area on the swell, 3 oil-bearing strata were found in the Sarmatian. It is possible that the deposit is of secondary origin due to migration from the Jurassic or to lateral migration from the Tertiary deposits filling the depression to the W. of the buried range in Romania. Both the Sarmatian and the Jurassic merit further attention.--C. Voûte.

2-2447. Zabirov, A.G. SOME FEATURES OF THE WATER-OIL CONTACT OF OIL POOLS OF THE DEVONIAN OF THE ROMASHKIN OIL FIELD: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 11-A, p. 943-945, 3 logs, 1958, [pub. 1960].

Some short comments are given on the position of the water-oil contact in several productive horizons of the Devonian. The position of this contact has been determined from a great number of logging diagrams and from well tests and some production data. It is more or less clearly marked only in individual wells; in most cases, however, there is a transition zone, the thickness of which varies from 0.5 to 5-6 m. According to the position of the contact and also to structural features, the field appears to be divided into an eastern and a western part which originally were one, but as a result of faulting were separated into 2 independent blanket pools that are not hydrodynamically related. Each part of the field shows hydraulic relationships between the different oil-bearing strata, which are expressed in similar levels of the water-oil contact and in a decrease of formation pressures during exploitation even in horizons which were not worked.--C. Voûte.

2-2448. Melnikov, A.M., and I.A. Shpilman. CURRENT PROBLEMS OF DEEP EXPLORATORY DRILLING IN TATARY: Geologiya Nefti - Petroleum Geology [in translation], v. 2, no. 10-A, p. 859-866, 3 maps, 1958, [pub. 1960], 5 refs.

The paper describes briefly the oil prospects for the Devonian and for the Carboniferous separately. On the main they seem to be rather unfavorable in the western part of the trans-Kama area, adjacent to the equally unproductive Volga region. In the eastern part of the area, however, in almost all the wells, oil shows are found in the Middle and Upper Devonian beds. This distribution of commercial oil accumulations, which occur both in structural uplifts and in stratigraphic traps, is explained by a more rapid subsidence of the western area, resulting in migration of the oil towards the E. Oil prospects in the Carboniferous are good in a much larger area of trans-Kama; however the oil is of the heavy S type, particularly in the western regions. The oil deposits of the Carboniferous are characterized by the small size and great variability of the reservoirs, which render the exploration more complicated. Most attention therefore is still being given to the discovery and development of high-producing Devonian fields. Exploration drilling thus far carried out is mentioned, and recommendations for continuation of the work are given, for instance with respect to spacing of the drilling and structures to be prospected.--C. Voûte.

2-2449. MacLeod, William. LIBYA - LATEST OIL PROVINCE: Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 3, p. 89-91, March 1960.

Since the first reconnaissance mapping by oil companies in 1953, the oil potential of Libya has reached the point where proved reserves of oil are 10 billion barrels, and probably will be of the order of 50 billion barrels, or about equal to Kuwait. The geology of Libya is relatively simple because there has been little disturbance. The Tertiary-Mesozoic Sirte basin is the site of the largest finds so far. Production from the Zelton field is at 5,700 ft. from Paleocene limestone.--M. Russell.

14. ENGINEERING GEOLOGY

ee also: Geomorphology 2-2223; Geophysics 2-2281.

-2450. RAND Corporation. **PROCEEDINGS OF
HE SECOND PROTECTIVE CONSTRUCTION SYM-
OSIUM:** Its: Rept. R-341, 2 v.: 988 p., illus., map,
raphs, tables, March 1959, refs.

The Proceedings of the First Symposium are clas-
ified and therefore unavailable. The 45 papers pres-
nted in this symposium bring together knowledge
hat is pertinent to the design and construction of
nderground structures, facilities, and hardware,
hat will continue to function after being subject to
ear-surface blasts from large nuclear weapons.
he design must provide for communications of vari-
us sorts, utilities (power, water, sewage), fresh
ir, temperature control, normal access when not
nder attack, and eventual evacuation. The chief
roblems will be caused by radioactivity, shock and
eat of the fireball, cratering, rupture and ground
hock of the explosion. Nearly all the papers deal
irectly or indirectly with geology.--R. Van Horn.

The papers given are:

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Libby, James W. Planning and Construction of Underground Facilities for Kemano-Kitimat Project, p. 711-727.

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Lang, Thomas A. Underground Experience in the Snowy Mountains - Australia, p. 767-853.

Cooke, J. Barry. Major Underground Excavations of the Pacific Gas and Electric Company, p. 855-882.

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Brode, H.L. Underground Phenomenology, p. 891-916.

Genensky, Samuel M. Some Comments on the Wave Propagation Study Group, p. 917-924.

Weidlinger, Paul. An Informal Progress Report on Some Theoretical Investigations on the Vulnerability of Deep Underground Openings in Rock, p. 925-961.

2-2451. Scheidegger, Adrian E. FLOW THROUGH POROUS MEDIA: Appl. Mechanics Rev., v. 13, no. 5, p. 313-318, May 1960, 53 refs.

A review of the present status of the theory of flow through porous media. The various possible definitions of a porous medium are described, and the empirical basis of the fundamental flow law (Darcy's law) is presented. It is shown that this empirical basis, in fact, allows for various conflicting formulations of the flow law. A brief summary of methods of solution of Darcy's law for particular cases is given. The limitations of Darcy's law are described, and it is shown how the latter can be extended to take account of inertia and adsorption effects. The theoretical aspects of Darcy's law are investigated, and a review is given of attempts at explaining Darcy's law in terms of fundamental hydrodynamics. Finally, the various types of displacement mechanisms important in ground-water hydrodynamics are discussed. --Auth.

2-2452. Ambraseys, Nicholas N. ON THE SHEAR RESPONSE OF A TWO-DIMENSIONAL TRUNCATED WEDGE SUBJECTED TO AN ARBITRARY DISTURBANCE: Seismol. Soc. America, Bull., v. 50, no. 1, p. 45-56, 5 figs., 3 tables, Jan. 1960, ref.

The present work consists of a theoretical investigation of the shear response of a truncated 2-dimensional elastic wedge subject to an arbitrary disturbance. Expressions are derived for the deflections and shears which develop in the wedge owing to an imposed time-dependent disturbance. The frequencies of the wedge are derived for the 6 first modes of oscillation and are given graphically for different degrees of truncation for the 1- and 2-dimensional cases. The solution derived is applicable to earthquake engineering problems, in particular to those dealing with the seismic stability of earth dams and embankments. The concept of strong ground-motion spectra is introduced and its advantages and limitations are discussed briefly.--Auth.

15. MISCELLANEOUS

2-2453. Tobler, W.R. MAPS OF THE UNITED STATES; A GUIDE TO WHAT MAPS ARE AVAILABLE, WHERE OBTAINABLE, & HOW TO ORDER: 32 p., illus., maps, Seattle, Washington, 1959, 11 refs.

A listing of the major map sources of the United States and description of the principal map series they produce. Emphasis is on basic topographic and cultural map coverage by the several agencies of the federal government. The following sources and series are described: U.S. Geological Survey; (7 1/2 min. quadrangles, 15 min. quadrangles, 30 min. quadrangles, the 1:250,000 series, the 1:1,000,000 International Map of the World, advance sheets, and state base maps); U.S. Dept. of Agriculture (aerial photographs); U.S. Coast and Geodetic Survey (sectional aeronautical charts, 1:500,000; world aeronautical charts, 1:1,000,000, nautical charts, at various scales); state, county, and city agencies. Sixteen private map companies are listed by name and address only.--M. Russell.

2-2454. Spurr, Stephen H. PHOTOGRAMMETRY AND PHOTO-INTERPRETATION, WITH A SECTION ON APPLICATIONS TO FORESTRY: 2d ed., 472 p., 151 figs. incl. illus., maps, diags., graphs, 19 tables, New York, Ronald Press, 1960, approx. 400 refs.

The first edition of this book, published as Aerial Photographs in Forestry, was designed as a textbook for forestry course work in photogrammetry and photographic interpretation, at the upper-class level. Most of its basic material on aerial photographs, photogrammetry, mapping, and photo-interpretation proved of value not only to foresters but also to geologists, soil scientists, botanists, geographers, and engineers. In this second edition, completely reorganized, largely rewritten, and therefore retitled, the presentation (in Parts I to IV) has been broadened to serve all nonphotogrammetrists who use aerial photographs as a professional tool. The chapters of Part V bring together the specialized material on applications to forestry and cover in some detail the use of aerial photographs in vegetation mapping, forest inventory, and forest management. Professional training in forest mensuration and in at least elementary statistics is presumed in the chapters dealing with forest measurements and inventory. --From pref.

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